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THE TRIP OF THE BATTLESHIP "OREGON," from Puget Sound to Key West, is described from a steam engineer's point of view in a letter written by First Assistant Engineer C. N. Offley, U. S. N., in charge of the starboard engine-room of the "Oregon." From this interesting letter, as published in the New York "Sun," we learn of the extreme watchfulness with which all the machinery of this ship was overhauled and cared for on the memorable trip. He gives a summary of the runs and coal consumption, which supplements a table already published by the Navy Department. In the following record the time while entering and leaving port is eliminated, the run commencing when the ship was fairly under way; the coal record does not include that used while in port, but does include coal consumed for all purposes while at sea:

From	To	Distance, knots.	Time, hrs.	Speed, knts pr hr.	Coal, tons.	Knots per ton coal.
Bremerton	San Francisco.	827.7	72	11.49	221.0	3.74
San Francisco.	Callao.	4,076.5	371	10.99	962.0	4.24
Callao.	Port Tamar.	2,529.9	212	11.93	785.0	3.22
Port Tamar.	Sandy Point.	132.0	9	14.55	66.0	2.00
Sandy Point.	Rio de Janeiro.	2,247.7	223	10.08	657.0	3.42
Rio de Janeiro.	Bahia.	700.0	*	*	288.0	....
Bahia.	Barbadoes.	2,229.0	193	11.55	620.0	3.59
Barbadoes.	Jupiter.	1,683.9	142	11.86	478.5	3.3
Jupiter.	Key West.	280.0	27	10.37	77.9	3.6
Total		14,706.7			4,155.4	

*Speeds variable; data unreliable.

THE TEMPERATURE OF WARSHIPS, at least in the fireroom, is usually something abnormal, and the "Cincinnati," an armored cruiser, has registered as high as 205°F. under forced draft. In both this ship and the "Raleigh," now with Admiral Dewey, this terrific fireroom heat is charged to reduced boiler space, under English rules, which crowded machinery of a high nominal power into a small space. When these ships were built the Engineering Department demanded room to install the boilers properly, but as 15 ft. would thus have been added to the 300 ft. fixed for the ship's length, the request was refused. It is pointed out that the specifications for the new battleships tempt builders to utilize the space provided by crowding into it high-power machinery, which will lead to like results. This is another incentive for reopening the whole question of design for these new ships; and late experience in tropical regions should in itself tend to a more decided regard for the health and comfort of the men in the fireroom. This part of the ship should be made at least endurable for the men whose services are too often overlooked in counting up our heroes.

THE ABSENCE OF HEAVY GUNS on the "Christobal Colon" in the Santiago fight is explained as follows by "La Tribuna di Roma:" The Spanish authorities refused to accept the two 254 mm. (about 10-in.) guns built at the Armstrong works at Pozzuoli for this ship, alleging defects in the sighting appliances. These were to have been replaced by two 9.6-in. Hontoria guns, but for some reasons which the Spanish naval authorities can alone explain, the "Colon" was sent to Cuban waters with guns of only about 5-in. caliber.

AN INCREASE IN THE CIVIL ENGINEER CORPS, U. S. N., is asked for by Commodore Endicott, Chief of the Bureau of Yards and Docks. At the present time this corps numbers 15 officers in all grades, and of this number, Mr. R. E. Peary is on leave in connection with his Arctic work. Messrs. A. G. Menocal and U. S. G. White are suspended from duty, and one or more others are on sick leave. This reduction in the active list especially embarrasses the service at this time, and the Chief of Bureau asks that the corps be permanently enlarged to 20 officers. As at present constituted, this corps includes one officer with relative rank of Captain, U. S. N.; two with the relative rank of Commander, one of whom, Mr. M. T. Endicott, is now Chief of Bureau, and ranks as a Commodore; three officers ranking as Lieut.-Commanders; four ranking with Lieutenants, and six ranking relatively with Lieutenants of the junior grade.

THE PLANS FOR RAISING the "Christobal Colon" are progressing under Naval Constructor Hobson. He has lately been experimenting with large rubber bags, or collapseable caissons. It is proposed that each of these shall have a lifting capacity of ten tons, and that they shall be lashed in place and inflated when sunk. The experiments being made at New York are to determine the strength and power of the bags and the efficiency of the air-valves.

HIGHER SPEEDS IN THE NEW BATTLESHIPS, "Maine," "Missouri" and "Ohio," are promised by at least five prospective bidders, in communications to Secretary of the Navy Long. These shipbuilders include the Cramps, of Philadelphia, the Newport News Co., the Union Iron Works, of San Francisco, John A. Dialogue & Co., of Camden, N. J., and the Harlan & Hollingsworth Co., of Wilmington, Del. These firms propose to submit their own designs for hull and machinery, subject to the approval of Chief Naval Constructor Hichborn and Engineer in Chief Melville. They provide that should these plans be satisfactory and speed greater than 16 knots be assured, the contract will be made with the successful firm.

A CLOUD-BURST occurred on Aug. 13 about 20 miles from Rogersville, Tenn., in which 17 persons were killed and several others injured.

A RAILWAY ACCIDENT near Genoa, Italy, in which 9 persons were killed and 40 seriously injured, is reported to have occurred on Aug. 11. A heavy freight train drawn by three engines became stalled on a steep grade in the Glori Tunnel. The tunnel soon filled with gases from the engines, which asphyxiated the engine drivers and firemen, leaving the train to run backward and crash into a passenger train standing at the entrance of the tunnel.

THE MOST SERIOUS RAILWAY ACCIDENT of the week occurred Aug. 10 near Pennington, Va., on the Louisville & Nashville R. R., as the result of a landslide. Three coaches rolled down a 60-ft. embankment, injuring about 20 persons, one or two quite seriously.

CHINESE RAILWAY AFFAIRS appear to be making some progress. A line is now under construction from Peking to Pao-ting-fu, 90 miles, and we learn that a Belgian company has closed an agreement with Director-General Sheng for the construction of a line from Pao-ting-fu to Hankow, a distance of about 600 miles. The railway from Shanghai to Woosung, 9½ miles, is expected to be opened for traffic about the end of August.

THE PARIS EXHIBITION OF 1900 will have a very large representation from the United States, and thus far the space allotted to the various departments is given as follows by Mr. Ferdinand W. Peck, Commissioner-General for the United States:

	sq. ft.
Agriculture and food products	20,000
Army and navy	3,300
Chemical industries	5,160
Education, instruments, practical sciences and arts	11,470
Fine arts	(not yet known)
Forestry, hunting and fisheries	3,300
Heating apparatus	4,500
Horticulture	(not yet known)
Machinery and electricity	50,000
Manufactures	25,000
Mines and mining	7,700
Textiles	13,000
Transportation and civil engineering	20,000
Total	163,430

THE FIRST AMERICAN LOCOMOTIVE for England has just been finished by the Baldwin Locomotive Works. It is a double-ender, intended to run between Barnstaple and Lynton, the latter place being a sea resort about 15 miles from Barnstaple.

THE LARGEST FREIGHT TRAIN EVER HAULED left Altoona, Pa., on the Pennsylvania R. R., bound for Columbia, Pa., on Aug. 9. The train was made up of 130 coal cars and was 3,877 ft., or only a little less than ¾ of a mile long, and weighed, exclusive of engine and tender, 5,212 tons, of which 3,693 tons was coal. Engine No. 872, belonging to Giant 45 class, which weighs 118 tons, and is considered to be the largest in the world, hauled the train. The 132 miles from Altoona to Harrisburgh were covered in 12 hours; in other words, the train made an average speed of 11 miles per hour.

TRACK ELEVATION IN CHICAGO has been carried on vigorously during the past two or three years, but at the end of 1897 less than half the work called for by existing ordinances had been completed. The following is an extract from the annual report of Mr. John O'Neill, Superintendent of Track Elevation:

Total track elevation provided for by ordinances ..... 45.7 miles.
Total track elevation completed Dec. 31, 1897 ..... 19.0 miles.
Total track elevation to be effected ..... 26.7 miles.
Total grade crossings abolished by ordinances 243
Total grade crossings eliminated Dec. 31, 1897 86
Total grade crossings to be eliminated 157
Cost of work provided for by ordinances $16,130,000
Cost of work executed, Dec. 31, 1897 ..... $6,050,000
Cost of work yet to be done $10,080,000

During the present year considerable work has been done by the Chicago, Milwaukee & St. Paul Ry., the Pennsylvania Lines, and by the Atchison, Topeka & Santa Fe Ry. at the complicated 16th St. crossing (Eng. News, July 14, 1898). The following is a list of the track elevation ordinances passed up to the end of 1897:

May 3, 1892—Illinois Central R. R., 47th St. to 71st St.; 3 miles; 13 crossings; $2,000,000. Completed.

July 9, 1894—Chicago, Rock Island & Pacific Ry. and Lake Shore & Michigan Southern Ry., from 16th St. to 69th St. and 67th St. respectively; 8½ miles; 41 crossings; $3,000,000. Nearly completed.

Feb. 18, 1895—Chicago & Northwestern Ry. (Galena Division); Sacramento Ave. to 46th St.; 2½ miles; 6 crossings; $400,000. Completed.

March 30, 1896—Chicago & Northwestern Ry. (Milwaukee Division); Wrightwood Ave. to Rosehill cemetery; 4½ miles; 20 crossings; $900,000. Completed. (Wisconsin Division); Armitage Ave. to N. 44th Ave.; 4½ miles; 48 crossings; $1,000,000. Work done in 1898.

July 27, 1896—Pittsburg, Fort Wayne & Chicago Ry.; 55th St. to 67th St.; 2 miles; 13 crossings; $750,000. Work partly done.

Jan. 18, 1897—Pittsburg, Fort Wayne & Chicago Ry.; State St. to Laurence Ave.; 1 mile; 2 crossings; $150,000.—Lake Shore & Michigan Southern Ry.; 61st St. to Laurence Ave.; 2 miles; 2 crossings; $1,000,000. Work partly done.—Chicago & Northwestren Ry.; Rockwell St., from Kinzie St. to Ogden Ave.; 2 miles; 19 crossings; $1,000,000. Completed.

May 17, 1897—St. Charles Air Line at 16th St.; 3 miles; 8 crossings; $2,000,000. Work in progress.

Dec. 2, 1897—Chicago & Northwestern Ry. (Milwaukee Division); Chicago Ave. to Diversey Ave. and Wood St.; 3 miles; 27 crossings; $1,200,000.—Chicago, Milwaukee & St. Paul Ry. (over the C. & N. W. Ry.); Chicago River bridge to Paulina St.; 0.5 mile; 3 crossings; $100,000.—C. M. & St. P. Ry.; Irving Park Boulevard; 6 miles.—C., M. & St. P. Ry. (Pacific Junction Branch); 0.6 mile.

A NEW WIRE ROD MILL of the most modern type is about to be built by Mr. William Garrett for King, Gilbert & Warner, at Columbus, O. The mill will use a 5-in. square billet, which is taken from the billet mill, after being sheared into lengths, to a heating furnace, where it is given a light wash heat, and then is delivered direct into the rod train. A letter from Mr. Garrett to the "Iron Trade Review" gives the reasons for locating the mill in Columbus, which is interesting in showing how the minor economies are being considered in modern steel works. We quote from it as follows:

In the past, Messrs. King, Gilbert & Warner have shipped the major part of their production to wire rod mills in Cleveland, in the shape of 4-in. billets, which, after being rolled into rods, have been reshipped through Columbus, to a large wire mill in Cincinnati. Owing to the keen competition in 4-in. billets, this see-sawing in the transfer of freight could not be tolerated. The freight on the billets from Columbus to Cleveland is 65 cts. per ton, and the freight on rods from Cleveland to Cincinnati is $1.20 a ton, making $1.85 per ton. Had the wire rods been manufactured at Columbus, the freight from Columbus to Cincinnati, 55 cts. per ton, would be the only expenditure for transportation, showing a clear saving of $1.30 per ton in freight. There is a further saving of about 50 cts. per ton in the manufacture of wire rods, when taking the hot billet, which is rolled from the initial heat of the ingot, and rolling this billet before it is cold into wire rods, making a saving of $1.80 per ton in favor of making wire rods in Columbus.

It may be said there are already too many wire rod mills in this country, which can now produce far more than we can at present consume. True; but are they correctly located to avoid this duplication of freight charges, and in such position relative to the steel mills as to take advantage of the initial heat of the ingot?

The day is not far distant when no firm that makes pig iron can afford to let it leave the works until it has taken advantage of the initial heat of the metal in every stage of manufacture, to put it into a marketable shape, which is entirely feasible in the case of merchant steel and wire rods.

THE POWER PLANT of the Hudson River Power Transmission Co. was started up on Aug. 9. This plant, it will be remembered, is situated about 18 miles from Schenectady, N. Y., and includes a concrete dam 2,000 ft. long and 18 ft. high, and a power-house which will eventually contain 28 250-HP. turbines driving 7 750-K-W. three-phase General Electric generators. At present only 5 generators are in place, and the current from these is transmitted to Schenectady, where it is used to operate a portion of the machinery of the General Electric Works.

ORNAMENTAL BRIDGES FOR LAKE PARK, MILWAUKEE, WIS.

We illustrate herewith a number of park bridges designed by Mr. Oscar Sanne, as Consulting Engineer for the Park Commissioners of Milwaukee, Wis., and erected in Lake Park of that city during the last few years. In designing these bridges Mr. Sanne was instructed to provide designs which should fulfil not only all engineering requirements, but should also be artistically worthy of the sites

FIG. 2.—VIEW OF 50-FT. STEEL ARCH HIGHWAY BRIDGE, LAKE PARK, MILWAUKEE, WIS.

the bridges were to occupy. The several views of the completed structures which we publish will enable each reader to judge for himself in what measure Mr. Sanne has succeeded in securing these results. The photographs from which these views have been engraved were furnished us by Mr. Sanne, and from a paper read by the same gentleman at the meeting on July 6 of the Western Society of Engineers, we abstract the following brief description of the different structures.

Fig. 1 is a side elevation of the smallest of the several structures, it being intended for pedestrians only. This bridge is composed of two 30-ft. and one 50-ft. plate girder deck spans. The girders are 30 ins. back to back of angles. This depth was considered the most effective one with regard to graceful appearance. The girders are placed 12 ft. 9 ins. c. to c., leaving a walk of 12 ft. clear width between railings. The bridge is supported by two bents of ornamental cast iron columns well braced. The abutments are of limestone masonry, with a hand railing of terra cotta on top of the coping. The cost of this structure was as follows:

Masonry and terra cotta railing	$1,398.45
Iron work	1,274.00
Total	$2,672.45

The second bridge shown (Fig. 2) is a 50-ft. steel arch, which carries the park driveway over a very picturesque ravine. It is composed of six 50-ft. steel arch ribs, with the front ribs shielded from view by a cast-iron ornamental cover. The four inner ribs are each composed of four 3 × 3½ × ⅝-in. angles, and one 18 ft. × 5-16-in. web plate, and the two outer ribs of four 3 × 3½ × 5-16-in. angles, and one 18 ft. × ¼-in. web plate. The ribs were calculated and constructed as arches with two hinges, and were figured for a live load of 100 lbs. per sq. ft. plus the dead load. The floor was figured for the same uniform live load, and in addition for a ten-ton road roller.

The roadway is 26 ft. wide resting on a floor support of I-beams and buckle plates; the roadway itself being composed of about 6 ins. of concrete, on top of which are laid 5-in. asphalt paving blocks. The sidewalks are 7 ft. wide, resting on I-beams, and are made of ⅜-in. cast-iron plates with diamond facing. The abutments are U-shaped, with very heavy buttresses for each arched rib. A terra cotta hand-railing is placed on the top of the coping. The cost of this bridge was as follows:

Masonry and terra cotta	$5,786.00
Iron work	4,265.65
Roadway floor and sidewalk	769.83
Total	$10,821.48

The third bridge, shown by Fig. 3, is a 35-ft. brick arch, which also spans a ravine. The ornamental parts of this arch were made of terra cotta, as well as the face stones of the arch proper. The arch is built of five rings of the best sewer brick, laid in Milwaukee cement. The faces of the spandrel and wing walls were laid with a very handsome brownish face brick. The sidewalks, 6 ft. wide, are made of concrete, and the roadway, 26 ft. wide, of macadam. An ornamental hand-railing of terra cotta surmounts the structure. The total cost of this bridge, which was let in one contract, was $10,449.

Bridges four and five were twin structures, and their general appearance is shown by Fig. 4. These bridges form the main entrance to Lake Park, and

FIG. 3.—VIEW OF 35-FT. BRICK ARCH HIGHWAY BRIDGE, LAKE PARK, MILWAUKEE, WIS.

are located in the neighborhood of the most desirable and finest residence property in the city of Milwaukee. It was, therefore, natural that these structures should receive great care and attention in their design. After a careful investigation of the peculiarities of the location, with due consideration of economy and utility, it was decided that the most satisfactory solution of the problem would be the adoption of an arch bridge, with open spandrels, so as to obstruct the view over the lake as little as possible.

These bridges were started in September, 1896, but owing to some difficulty in getting the proper stones, the work was badly delayed and the stonework was not finished until the beginning of October, 1897. The foundations offered no particular difficulties, as the bottom consisted of a very solid clay ground upon which the footings could be laid directly. To get a better distribution of the load, however, a layer of 2 ins. of sand was put under the footing course. The allowed pressure on the ground was 2½ tons per sq. ft. The foundation course consisted of selected stones not less than 12 ins. thick, and the masonry above the foundation and below the surface of the ground was rubble. Above the surface of the ground ashlar masonry with rubble backing was used. Stretchers were not less than 18 ins. thick, and each course above the skewback was of the same thickness of 16 ins. Below the skewback the stones varied from 16 to 17 ins. in thickness. Practically all the stones had to be cut stones with 1 in. chisel draft. The walls were provided with weepholes well-filled with broken stones for the purpose of drainage, and the filling behind the walls was cinders.

The bridges were calculated as two-hinged arches for a uniform load of 100 lbs. per sq. ft. plus the dead load. The floor proper was designed to carry a concentrated load produced by a steam roller weighing about 16 tons. In the calculation of these arches the effect of temperatures was also considered. Neither lateral nor sway rods were used, but ⅝-in. gusset plates and cross struts were placed at each panel point. The posts were bolted to cast-iron shoes. The floor of the roadway and sidewalks is carried by I-beams, upon which rest buckle plates ¼-in. thick. The roadway was made of 4 ins. of the best Trinidad asphalt resting on a 4-in. layer of concrete. The sidewalks are of Atlas cement concrete.

The hand-railing is of steel and cast iron. Due allowance was made in this railing for contraction and expansion by putting the ends of the railing into a pocket chiseled into the stone railing for this purpose. The abutments were finished by a cornice 2 ft. deep, and on top of this was put a plain railing. These two parts were originally designed for terra cotta, but as the cornice and railing could be obtained in Bedford sandstone for about the same price as the lowest terra cotta bid, it was concluded to use the sandstone. On the top of the half octagon of the hand-railing is placed an ornamental lamp-post with five lights.

The bridges are further ornamented by sculptured stone lions resting on heavy pedestals. The costs of these bridges were as follows:

Masonry, four abutments complete up to cornice	$14,977.64
Iron work, bridges proper, including iron hand-railing, buckled plates, lamp posts and guard rails	16,075.00
Stone railing and cornice	3,712.00
Asphalt floor for roadway, $2.50 per sq. yd.	1,177.50
Cement sidewalks, 14 cts. per sq. ft.	491.87
Electric and gas fixtures	138.90
Total	$36,572.97

THE WEST SUPERIOR COAL STORAGE PLANT OF THE LEHIGH VALLEY COAL CO.

By William R. Davis.*

(With two-page plate.)

A coal storage plant having several structural features of novelty and interest was built at West Superior, Wis., by the Lehigh Valley Coal Co., in the Fall and Winter of 1894-95. The plant consists of two steel buildings for anthracite, each 246 ft. in diameter, and 100 ft. high, and each with a capacity of 50,000 tons; a bituminous floor, with a capacity of 45,000 tons, and retail pockets for the local trade, Fig. 1. Bituminous coal cannot be piled to a greater height than 30 ft. in this plant—a precaution against spontaneous combustion—and is the only coal not stored under cover.

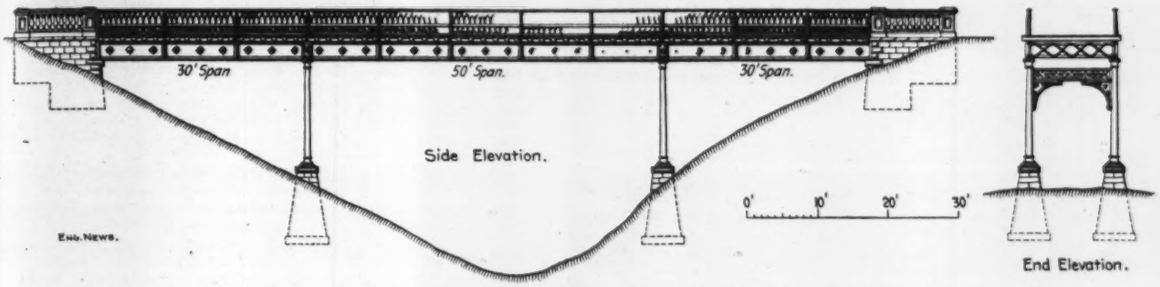


FIG. 1.—ORNAMENTAL PLATE GIRDER FOOT BRIDGE, LAKE PARK, MILWAUKEE, WIS.

The plant is located on Tower Bay Slip and through the local belt line railway has perfect shipping facilities. The wharf front consists of piling and cribwork. The original marshy ground on which the plant is built was filled in with sand, which was unloaded from scows by means of sand dredges. All foundations are supported on piles.

All coal is unloaded, put in storage and reloaded by machinery. Fig. 2 shows a sectional elevation of the anthracite plant. Coal from the company's mines in Pennsylvania, and loaded on boats at Buffalo, is delivered at the wharf in the open season from May to December. It is unloaded by automatic clam shell shovels of 2,000 lbs. capacity, furnished by the W. S. Bogle Co., of Chicago, and similar in most respects to those used in New York city. The towers carrying these shovels are of steel, 120 ft. high, and travel the full length of the wharf for use with either the anthracite or bituminous portions of the plant. The clam shell discharges into a hopper from whence the coal descends by gravity to the lower part of the ascending or trimmer trough. From this point it is handled by the Dodge system of endless chain conveyors. The trimmer trough has a movable bottom. Coal is first discharged through the open bottom at a point about 20 ft. inside the building, and the steel ribbon in the bottom is pulled ahead from time to time so that the coal will never fall more than a few inches.

The use of a steel roof compelled a novel departure in the form of the reloader. As usually constructed a single reloader lies between two piles of coal and operates into either at pleasure. In this plant the reloaders are pivoted at the center of each building (Fig. 3), and all coal is withdrawn through a cast-iron tunnel, below the floor. When the building is filled with coal the reloader is buried and lies directly over the axis of the tunnel. It is, of course, impossible to operate it then. The first coal, therefore, is removed through chutes suitably spaced along either side of the reloader, leading into the tunnel, after which the reloader is left uncovered and removes all that remains in the building. The coal discharged by either spouts or reloader into the tunnel is carried by a continuous chain conveyor extending along the tunnel and up an incline where it is passed through revolving screens into the pockets and loaded into the cars. The tunnel, which has an inside diameter of 7 ft., was cast with a body ⅞-in. thick, and ends 1¼ ins. thick. This has proved to be too light. It cracked in several places under full load, which is eccentric on account of an interior partition parallel and close to the axis of the tunnel. The cracks were patched and the tunnel braced immediately afterwards, however, and it has since given satisfactory results.

The Bogle Shovels have shown the following average capacity in anthracite for three shovels on a fair-sized cargo, from beginning to end of operation, viz.: For egg, 135 tons per hour; for stove, 165 tons per hour, and for chestnut, 185 tons per hour. The capacity of the anthracite plant has proved equal to that of the shovels. Each building can handle 185 tons per hour either into or out of storage when pushed.

The machinery for the entire plant, except that for the Bogle towers and the stationary engines, was furnished by the Link Belt Engineering Co., of Philadelphia, and the Link Belt Machinery Co., of Chicago, according to the designs of the Dodge Coal Storage Co., of Philadelphia, with Mr. Chas. Piez as chief engineer. The structural steel work was furnished by the Allentown Rolling Mills, of Allentown, Pa., with Mr. Frederick S. Guerber as chief engineer. The writer of this article was engaged on the design and was engineer of erection of the structural work. The erection of structural work and machinery was done by the Barnet & Record Co., of Minneapolis, Minn. The photographs by which this description is illustrated were taken by Mr. John A. Telner, Engineer of Erection for the Dodge Coal Storage Co.

Each building consists of 24 riveted trusses meeting at the center, which carry purlins covered with standard No. 22 corrugated iron. One truss, called the trimmer truss, and its opposite are made heavier and wider to carry the trimming conveyor and machinery, Fig. 4. The outer trusses were figured by graphic methods for the usual snow and wind loads under the different conditions of loading. It was required to design for safety with a view to rigid economy. To avoid the ambiguity attaching to the stresses when a central ring to which the trusses are riveted is used and secure a true three-hinged arch. There was designed a connection, believed to be novel and certainly original, which is shown by Fig. 5. It will be seen that the trusses are erected in four groups of six each. They are all alike until near the top pin, when a special "neck" brings the pins of each group to a level of its own. The plan in Fig. 6 shows how the two center trusses are straight and how the ends of the side trusses are bent. At the bend, cast-iron bearing blocks are used, as shown by the section in Fig. 6 to transmit the horizontal thrust from one side truss to the opposite one. The tongues and grooves are provided to prevent the possibility of undue distortion under excessive eccentric wind loads, and are used merely as an extra precaution.

Fig. 6 shows the working drawings of one group of necks. The others are similarly constructed. Separate pins are used for each pair of trusses, making three pins for each group, except the upper group, which contains the special trimmer trusses. In this case the truss narrows down to come on its bearing pin, but a stiffening member passes over the side trusses and down to two additional pins concentric with the other three (see Fig. 3), serving only to give added lateral stability to these trusses which were the first to be erected. The vertical space between the several groups was made as small as was consistent with freedom of erection. The thrust of the trusses is taken up by rods meeting in a heavy ring which lies outside the mouth of the tunnel and below the reloader.

In storage plants, as previously built in the east on the Dodge system, the coal had been heaped in piles which were perfect cones. In this plant, it was desired to save the outer space where the depth was small by using a retaining wall, as

FIG. 4.—VIEW OF 87-FT. STEEL ARCH HIGHWAY BRIDGE, LAKE PARK, MILWAUKEE, WIS.
Oscar Sanne, Milwaukee, Wis., Designing Engineer.

*1455 Washington Ave., New York, N. Y.

shown in Fig. 1, an arrangement which very much reduced the cost of the buildings.

Mr. James M. Dodge, President of the Dodge Coal Storage Co., proposed the method here described, and has patented it.

The wall consists of special corrugated iron, No. 16, or 1-16-in. in thickness, with a pitch of 5 ins., and corrugations 1 in. deep, manufactured by the Cincinnati Corrugating Co., of Piqua, Ohio. This is supported by 4-in. 7-lb. steel beams spaced 2 ft. 11 ins. apart between centers, and each anchored by two ¾-in. diameter rods, which are fastened to a steel plate 36 ins. × ¼-in., standing vertically in a solid ring, fully spliced with lap joints, and with a radius about 20 ft. less than that of the wall. The construction is fully shown by Figs. 7 and 8. The pressure on the wall was assumed to be that given by Trautwine (p. 686, art. 6; p. 689, Rem. 4). The following table is compiled by the Link Belt Engineering Co., from Trautwine's formulas, which are in reality those of Coulomb. The figures are based on 27° for the angle of repose, the true figure for large piles, and 52.1 lbs. per. cu. ft. for the weight of coal in smaller sizes. The writer does not wish to be understood as indorsing the theoretical correctness of the formulas:

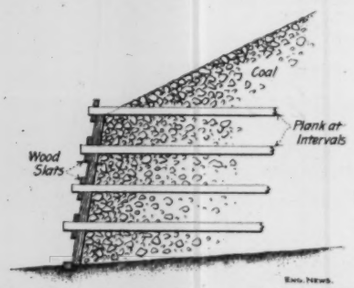


Fig. 10.—Sketch Showing Ordinary Method of Piling Coal.

Table Showing Pressure of Different Depths of Coal on Horizontal and Inclined Surfaces.

Depth, (d) in ft.	Horizontal surface. Pressure. Total.	Horizontal surface. Pressure. On lowest ft.	Sloping surface. Pressure. Total.	Sloping surface. Pressure. On lowest ft.
1	9.78	9.78	14.22	14.22
2	39.12	29.34	56.88	42.66
3	88.02	48.90	127.98	71.10
4	156.48	68.46	227.52	99.54
5	244.50	88.02	355.50	127.98
6	352.08	107.58	511.92	156.42
7	479.22	127.14	696.78	184.86
8	625.92	146.70	910.08	213.30
9	793.18	166.26	1,151.82	241.74
10	978.00	185.82	1,422.00	270.18
11	1,183.38	205.38	1,720.62	298.62
12	1,408.32	224.94	2,047.68	327.06
13	1,652.82	244.50	2,403.18	355.50
14	1,916.88	264.06	2,787.12	383.94
15	2,200.50	283.62	3,199.50	412.38
16	2,503.68	303.18	3,640.32	440.82
17	2,826.42	322.74	4,109.56	469.26
18	3,168.72	342.30	4,607.28	497.70
19	3,530.58	361.86	5,133.42	526.14
20	3,912.00	381.42	5,688.00	554.58

Note.—Surface horizontal: Total pressure for depth (d) = 9.78 d^2; pressure on lowest foot = 9.78 (2d — 1). Surface sloping, at angle of repose: Total pressure for depth (d) = 14.22 d^2; pressure on lowest foot = 14.22 (2d — 1).

The anchor rods were so spaced as to give nearly equal moments at the points of attachment and between. The working stresses were assumed to be 16,000 lbs. per sq. in. for both coal and wind loads. The horizontal wind pressure was assumed to be 30 lbs. per sq. ft. The only connection of the wall with the trusses was at the top of the beams, which merely rested against the strut at the hip, to take the wind reaction. It was thus intended to make it impossible that any of the coal pressure should be carried into the trusses, a precaution so that a failure of the wall might not involve a more serious failure. When storing coal, the band is first imbedded before any pressure comes on the wall, and, as shown in Fig. 1, the anchor band is well within the conical portion of the pile which gives no pressure to the wall. The reader will notice the similarity between this method and that long in use in which the wall is built of planks anchored by other planks running back into the face of the pile, as shown in Fig. 10. When the anchor band was erected it swung lightly upon the ¾-in. anchor rods without other support. To avoid undue strains from the weight of the coal, legs were provided about 8 ft. apart resting upon steel plates on a wooden sill, pivoted to swing clear for the reloader. This wall and the rest of the structural work has been entirely satisfactory, and no weak points have developed after three winters' service.

THE SHEARING STRENGTH OF RIVET STEEL.*

Five years ago the use of steel for rivets in high-grade boilers, stand-pipes and structures was considered doubtful practice by many engineers, and wrought iron rivets were used long after wrought iron plates had been displaced by steel. Steel rivet material of that day was unreliable and lacked the toughness and uniformity which is essential for standing the abuse of ordinary riveting operations. Improvements in manufacture have produced a steel rivet bar, which for toughness, uniformity and reliability, in fact for everything except the range of temperature allowable in riveting, is the equal of the best iron rivet.

Present practice in designing joints uses values of the shearing strength of steel based upon experiments made several years ago. The data frequently quoted are from experiments made in England by Prof. A. B. W. Kennedy in 1885. The shearing strength of these steels varied from 67 to 83% of the tensile strength. From these and other tests on the earlier structural steels, the ratio of the shearing strength of rivet steel to its tensile strength has been assumed to be 80%, and the ratio of this shearing strength to the tensile strength of the plate used in the joint, 75 to 83%.

As a contribution to the knowledge of this subject, the results of a series of tests made in the Laboratory of Applied Mechanics of the University of Illinois are presented. The tests first described were made by the different class divisions as regular laboratory work, and the later tests directly by Mr. C. V. Seastone, assistant in the Laboratory of Applied Mechanics. Three sizes of four varieties of rivet material were used, and tests were made both for single shear and double shear.

Four varieties of material were tested: 1. The Victor boiler rivet steel, manufactured by the Champion Rivet Co. of Cleveland, Ohio; 2. Best Boiler rivet steel, manufactured by Sternbergh & Son, Reading, Pa.; 3. Structural rivet steel (said to be Bessemer steel), manufactured by Sternbergh & Son; and 4. Best rivet iron, manufactured by Sternbergh & Son. Three sizes of each of these makes were used, ½, ¾ and 1-in. diameter. The rivet rod fitted the holes in the apparatus so accurately that it was not found necessary to turn the rods down.

The determination of the phosphorous and sulphur of the rivet material made by Prof. S. W. Parr resulted as follows:

	Per cent. Phosphorous.	Per cent. Sulphur.
Victor steel	0.025	0.043
Best boiler steel	0.011	0.051
Structural rivet steel	0.041	0.053
Wrought iron	0.058	0.000

The accompanying cut shows sections of the apparatus used for making the shearing tests. The apparatus for single shear, shown at a, consisted of two bars with accurately drilled holes through which the test pieces passed. A bolt through the slotted holes above the test piece and one through the holes below it, held the bars firmly so that the shearing planes remained together. Tests showed that the friction between these plates was small. The length of the bars (28 ins.) reduced the eccentricity of the pull to a very small amount.

The apparatus for double shear, shown at b, consisted of two middle bars ⅝-in. thick and an upper and a lower bar each 1 in. thick. The upper bar was fastened to the two middle bars with a 1½-in. bolt, and the test pieces passed through accurately drilled holes in the middle and lower bars. A bolt through a slotted hole in the middle and lower bars held them firmly together. The bolts and the stiffness of the middle bars prevented any bulging or buckling of the bars during the process of shearing.

The bars were tool steel of 80,000 lbs. tensile strength. The upper and lower bars were placed in the grips of the 200,000-lb. Olsen testing machine and tension applied. Little perceptible distortion took place in the test holes of the apparatus. The usual tension tests of the rivet material were also made. The steel rods were bent cold flat on themselves without showing flaws, and a 1-in. Victor steel rod was tied in a close knot by cold bending.

The sheared pieces are specially noticeable for the indentation which takes place after the elastic limit is reached. The shoulder or indentation was as much as 10% of the diameter, and increased with the diameter of the test piece. The bending action was slight and was scarcely noticeable on the compressed side. An examination of the pieces during and after the tests showed that this method of testing largely eliminates the flexural effect upon the rivet and hence is not subject to the criticism sometimes made upon shearing tests.

The average of the results of the tests are given in Table I.

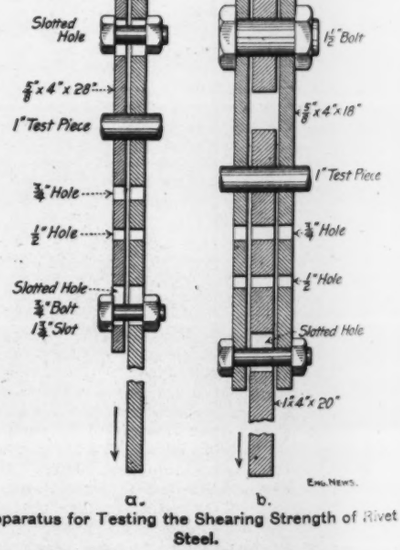
It would be interesting to know why the ratios for the small rivets are higher than those for the large. If bending entered into the results, the smaller rivets would have the smaller ratios. The table shows that the tensile strengths of the several sizes average almost exactly the same. To find whether the variation was caused by softer material in the large rivets, four test pieces of the larger sizes were turned down to ½-in. and tested for double shear. The results gave ratios within 1% of the ratios in Table I. for ½-in. rivets of the same material. It seemed probable that the increased bearing stresses in the larger size—the thickness of plate remaining the same—might be the cause, and the larger indentation in the larger test pieces corroborated this view.

To determine the effect upon the shearing strength of increasing the bearing stress, an apparatus for single shear was then constructed having the shearing bearing stresses 1⅔ times the former ones. The shearing ratio of the ½-in. rivets was decreased nearly 4% and the 1-in. 1¼%. As even with this apparatus, the ½-in. rivet did not reach the usual bearing stress, it is quite probable that the shearing ratio would be still smaller for the usual conditions of joints. These results tend to show that the amount of the bearing stresses affects shearing strength, the latter decreasing with an increase in the former. They, at least partially, explain the higher ratios for the smaller rivets in Table I.

To determine the effect of the hardness of the shearing plate upon the shearing strength of the rivet material, an apparatus for single shear was constructed with ⅝-in. bars of 56,000-lb. mild steel. With this apparatus not more than one or two rivets could be tested in a single hole, for the distortion of the plate became quite marked. The results are given in Table II. It will be seen that the shearing ratios have been increased about 4.6% over the corresponding values in Table I. This increase in the ratios

TABLE I.—Comparison of Shearing and Tensile Strengths of Rivet Material.

Diameter.	Tension. Ultimate strength, lbs.	Tension. Elastic limit, lbs., per sq. in.	Tension. Elongation in 8-in., %.	Tension. Reduction of area, %.	Single shear. Ultimate strength, lbs., per sq. in.	Single shear. Ratio of shear to tension, %.	Double shear. Ultimate strength, lbs., per sq. in.	Double shear. Ratio of shear to tension, %.
Victor Boiler Rivet Steel.								
½-in.	48,100	31,000	33	76	38,400	80.0	37,700	78.4
¾-in.	49,930	31,000	34	55	37,900	75.7	37,550	75.3
1-in.	47,350	31,150	37	65	34,500	73.3	34,700	73.3
Best Boiler Rivet Steel.								
½-in.	48,700	35,300	33	62	38,550	79.1	39,250	80.6
¾-in.	47,000	28,650	36	68	36,200	77.0	36,300	77.2
1-in.	49,330	30,600	32	70	36,100	73.2	36,200	73.4
Structural Rivet Steel.								
½-in.	55,400	37,700	26	70	43,400	78.3	42,100	76.0
¾-in.	55,900	37,350	29	64	41,700	74.6	41,900	74.9
1-in.	53,600	35,500	29	71	38,000	70.9	38,600	72.0
Wrought Iron.								
½-in.	49,600	37,750	25	46	40,200	81.5	38,200	79.5
¾-in.	50,200	31,200	38	48	38,600	77.0	39,100	79.8
1-in.	48,400	32,000	33	52	35,200	72.8	36,400	75.2



Apparatus for Testing the Shearing Strength of Rivet Steel.

*Abstract of a paper by Arthur N. Talbot, Professor of Municipal and Sanitary Engineering. Reprinted from "The Technograph, No. 12, University of Illinois.

more than neutralizes the decrease found by reducing the bearing areas to the values used in practice as discussed in the preceding paragraph.

TABLE II.—Tests to Determine the Influence of Soft Plates on the Shearing Strength of Rivets.

Material.	No of tests.	Ult. shear. strength.	Ratio shear to tension.	Inc. in ratio.
Victor rivet steel, ⅛-in....	1	41,500	86.3	6.3
Wrought iron, ½-in.....	1	41,600	83.9	2.4
Structural rivet steel, ½-in.	1	46,200	83.4	5.1
Victor rivet steel, ⅝-in....	2	41,000	82.1	6.4
Wrought iron, ⅝-in.....	2	40,400	80.5	3.5
Wrought iron, 1-in.....	1	37,000	76.4	3.6
Best boiler rivet steel, 1-in.	1	38,550	78.2	5.0

It may be considered, then, that for the usual bearing stresses, with mild steel plate and soft steel rivet metal, the ratio of shearing strength of the rivet to its tensile strength is less than that generally quoted, 0.80, and that 0.75 is a more probable value. It seems to be shown, also, that an increase in the bearing area of the rivet will give increased shearing strength to the rivet. The use of hard steel plates with soft steel rivets likewise decreases the shearing strength of the rivets.

In all the preceding discussion, comparison of the shearing strength of the rivet has been made with that of the tensile strength of the rivet itself. The ratio of the shearing strength of the rivet metal to the tensile strength of the plate will be lower yet. For 48,000-lb. tensile strength rivet metal and 56,000-lb. steel plate, the ratio is 0.65; and for 55,000-lb. rivet metal and 62,000-lb. steel plate, it is 0.68. These results indicate that the ratios commonly used in designing joints (the shearing strength of the rivets equal to three-fourths or five-sixths of the tensile strength of the plate) are too high and hence that rivet spacing should be made closer. While these conclusions are based upon results found beyond the elastic limit, it does not seem possible to obtain comparative data within that limit.

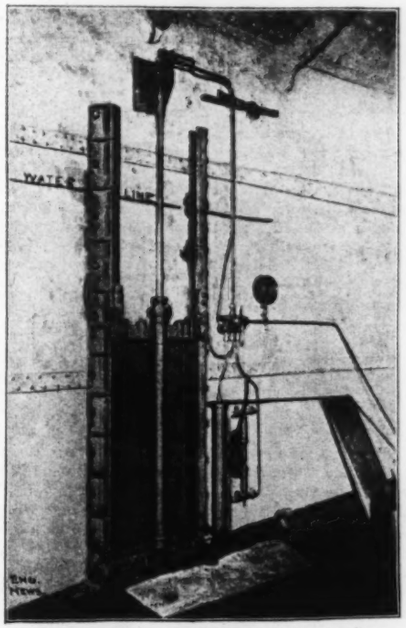
The writer does not accept the statement sometimes made that the shearing strength of rivets has little influence upon the strength of the joint, on the ground that the friction of the plates will hold the tensile stress well up to the elastic limit of the plate; for he does not think that it has yet been conclusively proved that the friction is so great. Tests made in the Laboratory of Applied Mechanics on riveted joints show that slipping occurs at or below the usual working stresses. The average of 22 double-riveted lap joints, hand riveted, gave 4,900 lbs. per sq. in., the maximum being 9,500 and the minimum 3,000. The average of 16 double-riveted butt joints, machine riveted, gave 9,000 lbs. per sq. in., the maximum being 13,000 and the minimum 5,500 lbs. Tests made elsewhere indicate that slip occurs at or below the usual working stresses, although some show much higher results. At any rate, it is not safe to assume that friction between the plates will prevent shearing stresses in the rivets, and with this view the shearing strength of rivet material becomes an important matter.

THE COWLES SYSTEM OF WATER-TIGHT BULKHEAD DOORS FOR THE U. S. CRUISER "CHICAGO."

One of the novel features of the reconstructed cruiser "Chicago," which will shortly be turned out of the Brooklyn Navy Yard ready for service, is the system of hydraulicly operated water-tight bulkhead doors, designed by Naval Constructor W. B. Cowles. To the layman the number of bulkhead doors, hatches and valves in the modern warships, which have to be closed often almost instantly in certain emergencies, is hardly appreciated. For example, the battleships "Indiana," "Massachusetts" and "Oregon," of the United States Navy, each has 272 water-tight compartments, with 354 doors and hatches and 294 valves, altogether 648 openings which have to be closed quickly under certain conditions. To close these openings and bring the cellular structure of the ship into operation in the case of an emergency requires, it is stated, the work of 110 men, exclusive of officers. It is easy to see, therefore, how in certain cases it may be practically impossible to bring all these safety devices into operation no matter how well disciplined the crew may be.

The cardinal ideas of Mr. Cowles' invention is to insure greater certainty of operation by taking it out of the hands of many persons and concentrating it by mechanical means into the hands of one stationed at a convenient central point. The problem involved several factors besides that of certain and safe central control of the valves and doors located in widely scattered positions. It was necessary to provide that the central control should involve no harm to the men whose duties might be in the various compartments by closing the avenues of escape independent of their will. Further, it was necessary that the doors should be such as would close against the pressure of water, or, in case of the bunker doors, through coal.

Two methods of central control, known as the "double line" and the "single line" systems, are employed. In the "double line" system the primary circuit consists of two cylinders with their pistons and rods connected by a double line of small piping in which is placed a controlling valve which governs the admission and release of pressure to and from the circuit and between the cylinders. The cylinders may be of any convenient dimensions, but while they are not necessarily duplicates, the corresponding ends must have equal piston displacements. One cylinder, called the power cylinder, is placed with its piston rod in connection with the device to be operated, for example, a bulkhead door, as shown by the accompanying illustration. The other cylinder, called the tell-tale, is placed at the point from which it is desired to operate the device. Operation is brought about as follows: The controlling valve is moved to the proper point, say, to close the door, when three things take place simultaneously: (1) Pressure is admitted to one end of the power cylinder causing its piston to move and close or otherwise shift the device; (2) the exhaust end of the power



View Showing Water-Tight Bunker Door Operated by Cowles Hydraulic System.

cylinder is connected with the corresponding end of the tell-tale, causing the piston rod of the latter to move over a scale indicating the exact time, rate and degree of movement in the device, and (3) the exhaust end of the tell-tale is opened to the exhaust tank. By throwing the controlling valve in the opposite direction the reverse of these operations occurs and the door or other device is opened.

Each device, it will be seen, has a separate run of pipe, a regulating valve and tell-tale, as well as individual operating cylinders, and can be operated by itself alone. The regulating valves and tell-tales are all located in one place, namely, the central station, and 120 sets may be placed on an operating board 40 × 80 ins. in size, projecting not more than 10 ins. from its face. The emergency attachment consists of a primary circuit, so arranged and connected that its power piston will simultaneously throw into the closing position any desired number of the controlling valves in the central station. The power cylinder of the emergency circuit is in the central station, but its tell-tale and controlling valve are placed at the point where the danger to be guarded against will most naturally first be discovered. The number of groups of central station valves controlled by emergency circuits can obviously be made as great or as small as desired.

To complete the power transmission system only one other device is necessary, which is the liberty valve. This is placed near the door or other device to be operated and consists of a spring controlled valve arrangement which may be operated by a person liable to have his escape shut off by the operator at the central station or at one of the emergency stations. The person in danger by simply throwing the liberty valve shuts the power off and thus arrests the closing of the door which it governs until he can escape, when the spring restores the normal condition and the door closes behind him.

The foregoing describes the "double line" system quite clearly. The "single line" system, which is the one employed on the "Chicago," works upon the principle of superimposing one pressure on another in the same pipe to obtain at will two separate and distinct ways of operating and controlling a device at a distance. This is done through a single pipe in combination with suitable valves, connecting pipes, and a power cylinder, much in the same general manner as in the "double line" system, but with one run of pipe in common for all devices instead of individual runs for each. There is, however, no central station such as there is with the "double line" system. Individual operation of a device is controlled by the liberty operating valve at the device, but the emergency operation of all devices simultaneously is controlled by a controlling valve and tell-tale placed at some central point.

The particular installation on the "Chicago" consists of eleven vertical sliding doors, all in the engine and boiler compartments, made of ¼-in. steel plates with vertical angle iron stiffeners and with manganese bronze plowshares to force a way through coal. The power cylinders for each door are made of seamless brass tubes. The system is operated by a steam accumulator and duplex pump of the Worthington type, which are placed under the protective deck. The hydraulic main is 2 ins. in diameter, reduced in suitable steps. The emergency gear consists of a power cylinder with a 4-in. stroke, operating the by-pass cock on the accumulator and a corresponding tell-tale and controlling valve in the conning tower, connected by a ⅛-in. pipe and forming a primary circuit. Ingenious devices are provided to tighten the doors at side and bottom. The side tighteners consist of traveling rollers held between a wedge track and a wedge bar, each of these latter being the full length of the door. The wedge track is secured permanently to the door, and the wedge bar rides with the door throughout its travel, except during the short tightening interval at the closing end of the stroke, within which the wedge bar is held stationary on the guide, thus causing relative movement between the wedge track and wedge bar on the rollers. This movement presses the wedge bar out against the guide lip, and the wedge track, with the door and seating strip, in against the seat.

Tests which have been made show the ability of bulkhead doors of this type to close against a head of water and also through piles of coal. Their operation and control are also proven to be satisfactory. The chief objection which has been raised to the system is that it adds another to the already large number of complex mechanical devices of the modern war ship.

NOTES AT DETROIT.

The city of Detroit claims the title of "the convention city," and the fact that it had 150 conventions last year seems to make good this claim. It has a special organization, the Detroit Convention and Business Men's League, whose object is to invite and secure the attendance of such gatherings, and to arrange for their entertainment. This is done in order to advertise the city and spread its reputation, although the direct advantage to trade seems to be doubtful. Mr. O. A. Bierce is Secretary of the league.

The city has an area of 29 square miles, a frontage of 9.2 miles on the Detroit River, and has a population of about 300,000. It is substantial and attractive in appearance, having wide, well-paved and remarkably clean streets, fine buildings, and an atmosphere free from smoke, in spite of the fact that the city has numerous manufacturing

establishments. A system of boulevards surrounds the city, and there are numerous large and small parks, while many of the streets are lined with trees. Woodward Ave. is probably one of the finest residence streets in the country. There are 235 miles of paved streets, exclusive of 11 miles of macadamized boulevards, and the paving includes 20 miles of asphalt and 20 miles of brick. Where car tracks are laid on streets having asphalt paving, brick is laid between the rails and tracks, the asphalt being brought close against the outer rails. At present there is a squabble between the City Council and the Board of Public Works as to the use of brick, the former favoring a ten-year guarantee, and the latter favoring the selection of brick by test. Under the present system the brick submitted by contractors are put through the rattler and absorption tests. Much of this class of paving requires repair in four or five years, and the requirement of a ten-year guarantee would, it is said, bring the cost up to that of asphalt. In the meantime but little brick paving is being laid. Both red and yellow brick are in use, and it is proposed to lay several kinds of brick on one street for actual observation as to the relative wear.

The city has 175 miles of main sewers and 276 miles of lateral sewers. The sewer system is now practically complete, and but little work is being done on extensions. Mr. Henry D. Ludden is City Engineer, which office includes also that of engineer for the Board of Public Works.

There are 167 miles of street railway and 71 miles of suburban lines, while 127 miles of suburban line are now under construction. All these are operated by electricity. In the paved streets grooved rails are used, and steel ties are used to a limited extent under heavy girder rails on concrete, there being only four ties to a rail. The cars are noticeable for their cleanliness and the good condition in which they are kept. There are two long electric lines running in competition with railway service; the Rapid Ry. to Mount Clemens, 15½ miles, and the Detroit, Ypsilanti & Ann Arbor Ry., to Ann Arbor, 38 miles. Mr. J. D. Hawks, M. Am. Soc. C. E., is Engineer and Manager of this road. Double-track cars, fitted with air brakes, are used on these lines, and baggage is carried in separate cars on the former and in combination cars on the latter.

The electric light plant is owned and operated by the city, and supplies 1,800 arc and 3,500 incandescent lamps, most of the former being mounted in groups on the tops of tall towers of iron framework. The report of the electric light commission, which has just been issued, puts the present cost of $83.50 per arc lamp, which the commission compares with a probable cost of $90 if the work was done by contract at this time. The city's water supply system dates back to 1824, and has been in charge of a water commission since 1852. There are two 6-ft. intakes and one 5-ft. intake, and three 42-in. force mains. The water is pumped direct through a distribution system of 526 miles of 2-in. to 45-in. pipe at presshure of 10 to 35 lbs. The pumping plant consists of four engines, three of which have a capacity of 24,000,000 gallons, while the other has a capacity of 35,000,000 gallons per 24 hours. There are 3,002 fire hydrants, 549 fire cisterns, and 73 hydrants in the auxiliary fire system. Meters were first introduced in 1889, and there are now 5,392 in service, which metered 19% of the entire amount pumped by the engines in 1897. The Fire Department has 21 steam engines, a fire-boat, 6 chemical engines and 417 men, while its equipment also includes 445 miles of fire alarm telegraph, 356 alarm boxes, and 581 reservoirs.

The Deep Waterways Commission, appointed by the government to investigate and report upon the proposed waterway connecting the Great Lakes with the Hudson River, has its headquarters in Detroit. This commission is composed of Mr. Alfred Noble, Mr. George Y. Wisner and Mr. G. W. Rafter, all members of M. Am. Soc. C. E. Parties are now in the field surveying routes from Lake Ontario and the Hudson River, one of which is proposed to utilize Lake Champlain as a part of the waterway. The preliminaries for the design of the lock gates are in charge of Mr. Henry Goldmark, M. Am. Soc. C. E., who has made extensive investigations as to the different forms of construction used in this and other countries. It has practically been decided to use iron gates, with a single skin, these gates being used in pairs. The full report of the commission will probably not be made until near the end of next year.

Detroit is a very important railway center, both for through and terminal traffic. It has a freight belt line and extensive freight yards, and in the city are three passenger stations for the twelve railways centering at this point.

The Michigan Central Ry., like the Grand Trunk Ry., has its own terminal station, and does not use the union station. Its general offices are in the station building. On this road a number of experiments with rail joints have been made, and it is now trying the Long and Fisher joints to a small extent. It has also 20 miles of track laid with a base-support joint, devised by Mr. A. Torrey, the Chief Engineer, in which a piece of inverted 65-lb. rail is placed under the ends of the 80-lb. track rails and secured by two, or in some cases three U-bolts, which pass under the inverted rail and have their ends secured by nuts above the flanges of the angle bars. This requires no lowering of the joint ties, as in joints having bridge plates which rest on these ties, and though the lowering is made light of by manufacturers of joints of the "bridge" type, Mr. Torrey finds that it is the cause of considerable trouble in track work. An experiment is also being made with short bars having studs on the ends, the distance between the studs being 1-32-in. less than that between the bolt holes. These clamps are put on hot (are on each side of the rail) and are covered by the angle bars. Notches cut across the rail heads by a Bryant saw, to represent joint spacing, have resulted in a rapid cutting out of the rail beyond the joint. Mr. Torrey is a believer in continuous rails, and has an experimental rail length of 500 ft. put up with turned bolts in drilled holes. The maximum expansion of this length is 4½ ins. The road has now 80% of its main track laid with 80-lb. rails, and 32-in. four-bolt joints are taking the place of the old 38-in. six-bolt joints. Rails for relaying have their ends cut off and are then laid upon a bed in lots of 80 rails, and numbered with chalk. A man then takes a special caliper and a box of 80 slips or "dominoes," and calipers the height of head at each end of each rail, marking the heights and the number of the rail upon a domino. When this is done he sorts out 60 of his slips, or "plays dominoes" with them until he has matched rail ends of the same height. He then re-numbers the dominoes in this order, and also numbers the rails in the same order with paint. A loading machine then loads the rails on the car, putting No. 60 first, so that in unloading on the track No. 1 will be the first rail handled. In this way good joints are secured at small cost. The 20 rails which do not match well go into the next lot.

Detroit is also one of the important lake ports, and the traffic through the Detroit River in 1896 included 33,290 vessels with an aggregate gross tonnage of over 35,000,000 tons. The traffic includes a great variety of craft, from small sailing and steam vessels and barges to the modern freight and passenger steamers of over 400 ft. in length, and the immense steel barges which some of the freight steamers tow as consorts. Among the most interesting vessels are the "Northwest" and "Northland" of the Northern Steamship Co., which resemble the Atlantic liners, and run from Buffalo to Duluth, an inland route of nearly 1,100 miles. Other notable craft are the fast sidewheel steamers of the Detroit & Cleveland Navigation Co., which runs from Detroit to Mackinac and Cleveland. These are driven by two-cylinder, compound vertical beam engines, of the type which has so long been a feature of American marine engineering. The dimensions of the "City of Mackinac," built in 1893 for this line by the Detroit Dry Dock Co., are as follows:

Length over all	275 ft. 0 ins.
Beam	38 " 6 "
Width over guards	68 " 11 "
Depth	15 " 0 "
Gross tonnage	1,736 tons
Cylinder, h. p.	42 x 88 ins.
Cylinder, l. p.	66 x 132 "
Boilers, two double-ended	12 x 19½ ft.
Speed, in regular service	18 miles per hour
Paddle-wheels, diameter	25 ft. 7 ins.

The manufacturing industries of the city are numerous and varied, including steamships, marine and stationary steam engines, gas engines, salt and soda-ash, railway cars, stoves, paint, sulphite fiber, and a multitude of smaller industries. There are in all about 2,000 manufacturing establishments, employing about 50,000 persons. At Wyandotte, about 12 miles down the river, are the remains of what is said to have been the first Bessemer steel plant established in this country. According to local accounts, a Detroit man went to England to negotiate with Bessemer, but the latter declined to make any agreement, and the former then obtained employment in Bessemer's works as a sand shoveler. Having learned the secret of the process he returned to this country, and, about 1860, established the Wyandotte plant, where steel was made, plates were rolled and a ship was built of these plates.

The Detroit Dry Dock & Engine Works Co. has a dry dock and shipbuilding yard at Wyandotte and another dry dock and an engine works in Detroit. The members of the American Society of Civil Engineers visited both plants, and examined the steel freight steamer "Troy," 425 ft. long, recently launched by the New York Central R. R. Its single screw will be driven by a quadruple expansion engine, supplied with steam by Scotch boilers, carrying 220 lbs. pressure. Considering the comparatively short runs, however, it is questionable whether there will be sufficient economy in fuel to compensate for the increased cost and complication of the engine. In this ship even the deck houses are of steel plating, and a somewhat peculiar arrangement is an anchor protruding from the stern. A portable pneumatic riveter was used for much of the work, especially for countersunk rivets in the deck plating, a pneumatic hold-on being applied underneath. A pneumatic chipping chisel cuts off the slight projection of the rivet above the plate, and it is then smoothed down by the riveting hammer. Steamers, engines and boilers for the Klondike service are also being built. At the shipyard is a drilling machine which is held up to its work by magnets, and the boilers are fitted with a very simple but effective smoke consumer, designed by the superintendent of the yard. It consists of a sliding and a fixed grating the whole size of the furnace door, and by regulating the admission of air above the fire by this damper, smoke can be entirely prevented. This was shown by opening and closing the damper, and the consequent disappearance or appearance of smoke from the stack. At the engine works is a shaft which was bought for iron, but which on being heated and put under the hammer broke with a fracture that showed simply a mass of granules or crystals which could be rubbed apart in the hand.

The Detroit Bridge & Iron Works is not now very busy in the shops, but has some large plate-girder through span having the ends rounded for the sake of appearance. These are for the Paragould Southeastern Ry., of which Wm. H. G. Kelly is the Engineer. This firm built most of the spans of the new Grand Trunk Ry. bridge at Montreal, which has been described in our columns. It has completed the erection of all the spans except the channel span, which is the longest. Owing to the headway required under this span a shallow floor was necessary, and this consists of transverse 24-in. 100-lb. I-beams, placed close together and covered with a plate to which the track rails will be bolted. The erection of the new trusses is done from a traveler like an inverted U which straddles the old tubular spans, the horizontal top member resting on trucks which run on rails laid upon the top of the tube. Several of the miter-cutting and shearing machines in the shops are mounted on turntables, so that they will cut work at any angle, thus avoiding the trouble of swinging long angle iron, etc., at an angle to the machine. Compressed air riveters and hoists are largely used, the latter having a valve devised by the shop foreman to regulate the admission of air according to the load, and so obtain a uniform speed of hoist. Railway turntables, with a pedestal bearing of turned conical rollers between planed and finished plates, are a specialty of this firm, and were described and illustrated in our columns some time ago.

The Detroit Graphite Manufacturing Co. has supplied nearly 8,000 gallons of its gray paint to the Navy Department for painting our warships

the present service color, and considers that it is entitled to some credit for thus making the ships so nearly invisible that the Spanish gunners could not hit them. The company's paint is also specified by the War Department for the guns, gun carriages, etc., of the coast defenses. The viaduct of the Detroit Union Station Co. crossing a number of freight and switching tracks was painted with the graphite paint in 1893, and shows no signs of rust or deterioration, although it is constantly subjected to the smoke and gases from engines standing or passing under it. On one of the columns which has been damaged by a derailed car, the broken edges of the paint are pliable and tough, and the rust on the part where the paint has been knocked off has not spread under the paint. This paint is used extensively for bridges and structural iron work, and also for cars, gas tanks, boilers, smokestacks, etc.

The Frontier Iron Works are now making a specialty of gas engines, as the number of engine works established by shipbuilding works has materially reduced their former business in marine engines. Single-cylinder vertical engines are built of from 1 to 10 HP., and double-cylinder horizontal engines are used for powers of 10 to 100 HP. The special feature of these latter engines is their steadiness of running, which makes them well adapted for electric light plants, and we shall shortly illustrate and describe one of these engines.

The Griffin Car Wheel Co. has its parent plant at Detroit, with branches at Chicago, St. Paul, Denver and Tacoma. This company is distinct from the New York Car Wheel Co., which also operates the Griffin patents and has plants in the eastern states and in Europe. The Detroit plant has a capacity of 250 wheels per day, a large majority being of 33 ins. diameter. A bottom-pouring ladle is used, the 2½-in. hole in the bottom being opened or closed by a graphite plug on a rod in the ladle, which is operated by a lever. This device, which is patented, ensures the pouring of clear metal and the exclusion of dross. Each ladle holds a little more than enough iron for a wheel. The wheels are kept in annealing pots for five days. Street car wheels are a specialty, and these have curved spokes. A great source of trouble is the variety of tire and flange sections demanded for these wheels, there being no standard, as in railway wheels. This lack of uniformity results in considerable expense for chills. General castings for locomotive and bridge work, etc., are also made, and for specially hard metal, steel rail scrap is melted with the iron. An unusual system of accounting is in force here, under which the books are closed and balanced for profit and loss every month.

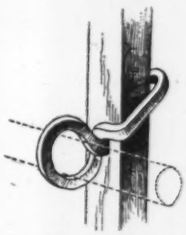
The Michigan-Peninsular Car Co. has two separate car works and a rolling mill, employing in all some 4,000 men, and turning out about 100 freight cars per day. The north works (or the old Penisular Car Works) have a capacity of 52 box cars per day, and have built 54 flat cars in a day. Tracks with turntables at the intersections are laid through the yards and buildings. In the machine shops are several multiple drills, some with six drills for drilling arch bars for trucks, and one with eight drills for miscellaneous work. Two men work at this latter machine. Wheels are pressed on their axles by a 50-ton hydraulic press. There is one foundry for axle boxes and miscellaneous work, and another for car wheels. The latter has a capacity for 400 wheels per day, and is equipped with the Whiting system of cranes and trolleys to handle the flasks, etc., and to carry the wheels to the annealing pits, where they remain for from three to five days. There are four regular cupolas, and a fifth for testing work.

In the woodworking shop the wood passes forward all the time from machine to machine, until it leaves the further end of the shop ready for the erecting shop. In this latter shop separate gangs of men attend to setting up the "bottoms" or underframes, the floor, side framing, sheathing, roofing, etc. All parts are cut, bored, mortised, etc., to templates, so that the apparently complicated framing goes together rapidly, like a child's puzzle in the hands of an expert. This, together with the systematic handling of material, and the division of labor, expedites the work and keeps the labor cost down to a minimum.

These works have now orders in hand, among others, for 500 box cars, 34 ft. long, for the Chicago, Rock Island & Pacific Ry., and 3,000 box cars, 36 ft. long, for the Baltimore & Ohio R. R. The largest cars ever built here, and perhaps the largest freight cars ever built, are some furniture cars for the Chicago, Rock Island & Pacific Ry. These cars are 50 ft. long and 9 ft. 2 ins. wide, of 60,000 lbs. capacity, and drawings of these we shall give in a later issue.

A GERMAN CLAMP CONNECTION FOR STAGING CONSTRUCTION.

The accompanying sketch shows a clamp connection invented by Mr. Ludwig Gauby, of Oedenburg, Germany, to be used instead of bolted or spiked connections in constructing stagings for building construction of all kinds where the ordinary staging of vertical and horizontal timbers in several stories is used. The method of applying this clamp to the vertical post and the manner in which the horizontal member is inserted through the eye is made clear by this sketch. In Germany the common practice is to use round timbers for staging, and the eye of the clamp is, therefore, made circular, but it is plain that this eye can be made rectangular and of the proper size to fit the square timbers commonly used for staging in America. To all appearances this clamp should be a very useful device wherever staging in large quantities has to be used, as it enables the timber to be used over and over again without damage, is easily removed and shifted to a new point, and allows of almost any desired variation in vertical adjustment, besides being cheap, compact and easily handled by any workman of ordinary intelligence. According to the circular which we have received describing this clamp, it is quite extensively used in Germany, and has given good satisfaction.



A German Clamp Connection for Staging Construction.

Ludwig Gauby, Oedenburg, Germany, Inventor.

WATER SUPPLY FROM THE SAND DUNES OF THE NETHERLANDS.

In commenting upon the water supply of Amsterdam, U. S. Consul G. J. Corey speaks of the sand dunes along the coast as the great source of fresh water. These dunes are formed of sand blown up from the seashore; the basis is sand, but peat is mixed with it in some places, and at the sea-level layers of compressed peat are frequently found; but never on the side nearest the sea. The dunes near Haarlem have a base width of nearly 2½ miles, with summits 20 to 23 ft. above the sea.

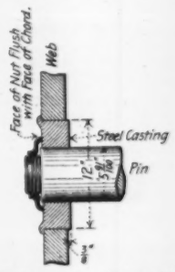
The rainfall percolates through the sand and flows landward and seaward; and the contained water is not only fresh to the sea-level, but to a depth of 66 ft. below sea-level. This would indicate that either the subsoil is based on fresh water, or the hydraulic pressure of the dune water prevents the entrance of sea-water; it is also possible that the water, originally salt, has become freshened by the dune-water pressure.

The quantity of water percolating through the dunes, and contributing to ground-water supply, is estimated at 11.91 ins. per annum. From a range of dunes 2½ miles wide, the quantity of water thus percolating is estimated at 240,000,000 gallons per year per kilometer (.62 mile) of dune length. This quantity can not all be drawn off, however, as a certain volume must be permitted to flow both ways to counteract the pressure of salt water coming from both sides.

For the Amsterdam supply the water is collected in open canals, which are always above the sea level. For the Hague water supply the water is always collected in stoneware pipes, in a bed of shells, 13 ft. below sea-level. In Haarlem the water is collected in wells sunk 50 to 60 ft. below sea-level. This water contains much iron in solution, and it has to be filtered at the three cities named; and when gathered in wells or in pipes it must be aerated before being filtered. The deep drainage system has been in operation for a short time only, and the Haarlem works are still incomplete.

BUSHED PIN CONNECTIONS FOR THE SURPRISE CREEK ARCH, CANADIAN PACIFIC RY.

The novel expedient of bushing the connecting pins was adopted in constructing the 290-ft. 4½-in. steel arch recently constructed over Surprise Creek, on the Canadian Pacific Ry. The main span of this structure consists of two braced steel arch ribs with 6-in. pin connections at the panel points of both top and bottom chords. These pins give sufficient bearing for the posts, diagonals and the top chords, but not sufficient for the heavy pressures of the arched bottom chord. The bearing area of the last members was, therefore, extended by the use of steel disks, or bushings, of the form shown by the accompanying illustration. The general design of this bridge was worked out under the direction of Mr. P. A. Peterson, M. Am. Soc. C. E., Chief Engineer, Canadian Pacific Ry., and the details were developed by the contractors, the Dominion Bridge Co., of Montreal, P. Q.



Bushed Pin Connection for Surprise Creek Steel Arch, Canadian Pacific Ry.

THE RUSSO-CHINESE AGREEMENT, of March 27, 1898, relating to Port Arthur and Ta-lien-wan, is given as follows by the "Peking and Tientsin Times," from what that journal considers a thoroughly reliable source: For the due protection of the Russian Navy the Emperor of China leases to Russia Port Arthur and Ta-lien-wan, together with the adjacent sea; but China reserves her sovereignty over this territory. The limits of the territory transferred are to be fixed in a treaty to be made at St. Petersburg. After such treaty all land within this territory held by Chinese shall be considered as leased by Russia for a period of twenty-five years; though this period may be extended by mutual agreement. One high Russian official shall control all military forces and all civil officers within this region; all Chinese soldiers shall withdraw, but ordinary Chinese inhabitants may remain. It is agreed that Port Arthur shall be a naval port for Russia and China alone, and it will be closed to the warships and merchant marine of all other nations. Part of the harbor of Ta-lien-wan will be a commercial port free to all nations; but another part of this harbor shall be exclusively reserved for Russian and Chinese warships. Russia has the right to build, at these two places, forts, barracks, etc. China agrees that the procedure sanctioned in 1896 regarding the construction of railroads by the board of the Eastern China Railway shall, from the date of the signature of this treaty, be extended so as to include the construction of a branch line to Ta-lien-wan, or, if necessary, in view of the interests involved, of a branch line to the most suitable point on the coast between Newchwang and the Yalu River. Further, the agreement entered into in September, 1896, between the Chinese Government and the Russo-Chinese Bank shall apply with equal strength to this branch line. The direction of this branch line and the places it shall touch shall be arranged between Hsü Ta-jên and the board of the Eastern railroads. The construction of this line shall never, however, be made a ground for encroaching on the sovereignty or integrity of China.

A STEEL HIGHWAY TRACK has been recently invented by Mr. H. L. Stillman, of Charlestown, R. I. For the flat-wearing surface he proposes to use worn-out T-rails with the head sawn off and the base inverted. The stringers are made by sawing diagonally through a block of wood twice as wide as it is high, and then using these two blocks so that the tops are inclined towards the center, and the web of the T-rail is placed between the blocks and secured by a bolt passing through the rail and the two blocks. Flat, or bar iron strips are bolted to the inclined surfaces, and the result is practically a steel trough, with inclined sides and a flat bottom formed by the inverted rail base. The inventor claims that by using these old rails a single track road of this type can be built for less than one-half the cost of an ordinary macadam road of single width.

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It is pleasing to note that, in addition to Naval Constructor Hobson, other staff officers of the United States Navy obtain recognition for their services, in the list of officers recommended for promotion by the Secretary of the Navy. In this list are six Chief Engineers and one Passed Assistant Engineer. While all of these officers of the Steam Engineering staff have well earned their promotion, Chief Engineer Robert W. Milligan, of the battleship "Oregon," especially deserves this recognition, for it is to his unceasing care and attention to the machinery of his ship that the country is indebted for the wonderful run made by this warship, from the Pacific to the Atlantic coast of the United States, and also for the speed developed that insured the surrender of the "Christobal Colon" in the Santiago fight. In the popular admiration for the so-called fighting men of our navy we are too apt to forget the men in the engine-room; yet it is upon the thorough training, technical skill, unending watchfulness and devotion to duty of the steam engineering staff, under conditions that try to the utmost the physical and moral endurance of men, that the captains of our warships practically depend for their victories. A modern battleship would be a useless, floating hulk, without the aid of a multitude of motors that propel and handle the ship, supply ammunition and point the guns and perform many other almost equally important offices. The efficiency of these motors, the manner in which they perform their many offices, is the measure of the efficiency of the warship; and this great responsibility rests upon the shoulders of the engineering staff alone. It must also be remembered that, unlike the officers on the deck, who have the enemy in sight and are nerved to the utmost endeavor by all the excitement of battle, the engineer officers perform their equally important duties shut up in the hold of the vessel and subjected to terrific heat. They cannot personally note the progress of battle; and they only know that in case of torpedo attack or ramming they may be sent to the bottom without ever seeing their destroyer. With a fire-room temperature sometimes exceeding 200° F, the strain upon officers and men is something terrific; and the skill of the first and the unselfish devotion to duty of the latter, as more than once exemplified in the present war, should never be forgotten by the people of the United States.

From a private letter printed in the New York "Sun," from First Assistant Engineer C. N. Offley, U. S. N., in charge of the starboard engine-room of the "Oregon," we gather some hints as to the reasons why this ship made a run of nearly 15,000 miles at an average speed of 11 knots, and yet was in such good condition that she was at once ready for battle on her arrival in Cuban waters. In the first place, the machinery of this ship was well designed, strong in all details; and what was even more essential, it was erected in the ship with the utmost care and thoroughness. But with these qualities given, the strain put upon it in this long voyage was such that would have told upon the best machinery, had it not been kept in constant and thorough repair in all its parts. We find by the letter of Mr. Offley that at every stop in port, connections were overhauled, brasses were examined, cleaned and scraped where necessary, air pumps and circulating pumps were cleaned and repaired, and main cylinders and valve-chests were wiped out and oiled. Equal attention was paid to the boilers, and every leak in pipes, engines, etc., however small, was carefully stopped at once, so that the evaporators and distillers, of 5,000 gallons capacity daily, practically supplied fresh water alone to the boilers. Every endeavor was made to avoid the use of salt water in the boilers; and to the success of this endeavor the record made by the "Oregon" is largely due. In a word, from the day this ship went into commission, the constant effort of her Chief Engineer was to keep all machinery as near perfection as human skill and never-ceasing watchfulness could make it. The whole record of this battleship, taken together, reflects equal honor upon her designers and builders, and upon those who maintained her utmost efficiency under most unusual and trying conditions; conditions never equaled by any other warship of the "Oregon" type.

The complaints of bad water at the various camps of the United States Army raises the question, what is possible in the way of purification where supplies naturally pure are unavailable? The answer depends upon a variety of conditions, the most important of which are the nature of the impurities and the permanency of the camps. Obviously the removal of mud and bacteria are quite different problems, while methods available for permanent camps are quite out of the question for temporary ones. Settling basins or coagulation combined with filtration will remove mud, and sometimes the two processes may be used to supplement each other. Filtration alone, either with or without coagulants, will remove bacteria, if properly conducted. Either distillation or simple boiling are highly effective, but even the latter is very expensive, while the former is so costly as to render it almost impracticable. Where recourse must be had to such extreme measures only water designed for drinking is likely to be treated, and a dual supply, or pure and impure water, in a camp or elsewhere is always dangerous, it being almost impossible to compel even disciplined soldiers to take any extra trouble to secure pure water when there is no physical difference between it and the impure, as is often the case with sewage-polluted as contrasted with unpolluted water. In addition, distilled or boiled water is lacking in oxygen and thus tastes flat, and is unpleasantly warm, unless it is artificially aerated and cooled, which means so much added expense as to render such treatment unlikely. Coming now to filtration, wherever there is a choice between a large central and numerous small, isolated filter plants, the central plant should by all means be chosen as certainly the cheapest and almost invariably the most efficient. That one plant is cheaper than several is too obvious to need explanation; that it is almost sure to be more efficient may not be so self-evident, though none the less true. The reason for this is that the greater the number of filtration plants the less will be the skill of the men in charge. Where camps are not permanent the smaller filter plants may have the advantage of greater ease in transportation, but there may also be more danger of breakage, as the filters or parts of filters are liable to be more fragile as they diminish in size. In general, it may be said of nearly all the portable, so-called domestic filters, beware!!! This by no means applies to all of them, IF they are well cared for. Generally speaking, the freer the filters work, meaning by those of the stone or earthenware type, the less efficient they are. All of them must be cleaned with frequency and care, and sterilized from time to time, the frequency of sterilization depending on the character of the filter. The slow-working porcelain or baked clay filters must operate under pressure, or give extremely low rates of filtration. In conclusion, it may be said that unless it be in the rarest emergencies there is no excuse for typhoid fever in any of our military camps, for at the worst boiled water can almost always be made available as an emergency supply, and the strictest orders issued against drinking any other water, thus throwing the responsibility on the individual soldiers. For a permanent camp it is doubtful whether the government would be justified in shifting the responsibility in this manner, except under the most pressing circumstances, although it is certainly open to question whether severe military punishment should not be given a soldier who endangers his life and that of his companions by carelessly drinking impure water when pure is easily available, especially in view of the severity of the penalties imposed for the infraction of rules which are really less essential to military success.

The slight buckling of some of the members in four of the six stiffening trusses of the Brooklyn Bridge, which was briefly noted in our issue of Aug. 4, calls much needed attention to the necessity of a more rigid regulation of the surface-car traffic over that structure. Among those best informed, it is almost needless to say, there has never been any doubt as to the ability of the bridge to carry the surface cars with absolute safety. It has been equally recognized, however, that if this load was not uniformly distributed, that is, if the trolley cars were to be frequently bunched together over one portion of the suspended structure, while other portions were clear, the strains in certain parts of the structure might assume an undesirable and perhaps an unsafe character. Both of these facts were clearly pointed out by the Board of Experts appointed to investigate the feasibility and practicability of permitting the surface and elevated cars to cross the bridge, in their report of Feb. 8, 1898 (Eng. News, Feb. 18, 1898). After reviewing the different phases of the question carefully, the Board of Experts concluded that the additional load could be carried with perfect safety upon the conditions that:

> The tracks be placed next the outer trusses, and that the minimum clear distance between cars while on the suspended structure shall be 102 ft., and that their speed shall not exceed seven miles per hour.

So important was the strict obedience of this regulation respecting headway considered to be by the Board of Experts, that the remaining four conditions were devised to insure its being enforced beyond doubt, and, finally, the Board advised that at the start the trolley car service should be limited to not more than one-half the number of cars that the railway companies deemed necessary until the employees became sufficiently skilled in the duties they had to perform to ensure that the proper headway would always be preserved.

Notwithstanding the emphasis with which the observance of a perfectly safe interval between cars was insisted upon by the board of expert engineers, and despite their contract agreement to observe it, the surface railways have paid very little attention to the regulation of their traffic in that respect. In fact, as everyone knows who has had occasion to cross the bridge on the surface cars, it has been the exception when the proper headway has been observed. During the hours of heaviest traffic in the morning and evening cars are often run with an interval of barely a car length between them, and on a number of occasions a blockade has packed a part or the whole of the suspended structure with cars only a few feet apart. It was such a blockade which, com-

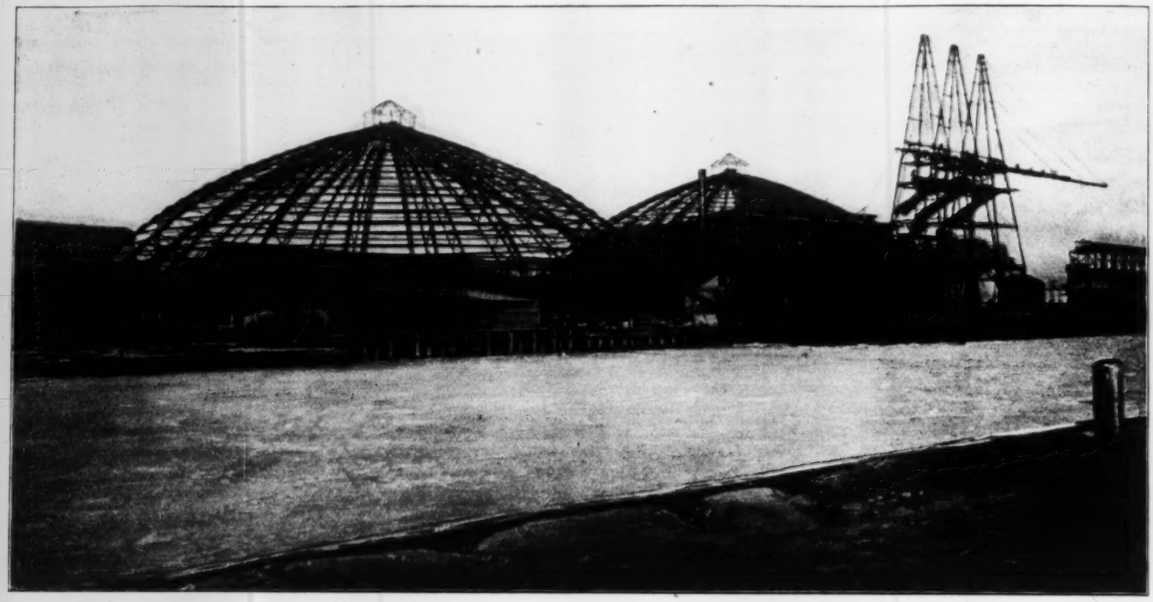


FIG. 1. GENERAL VIEW OF ANTHRACITE AND BITUMINOUS PLANTS WITH WHARF CONVEYOR AND TOWERS.

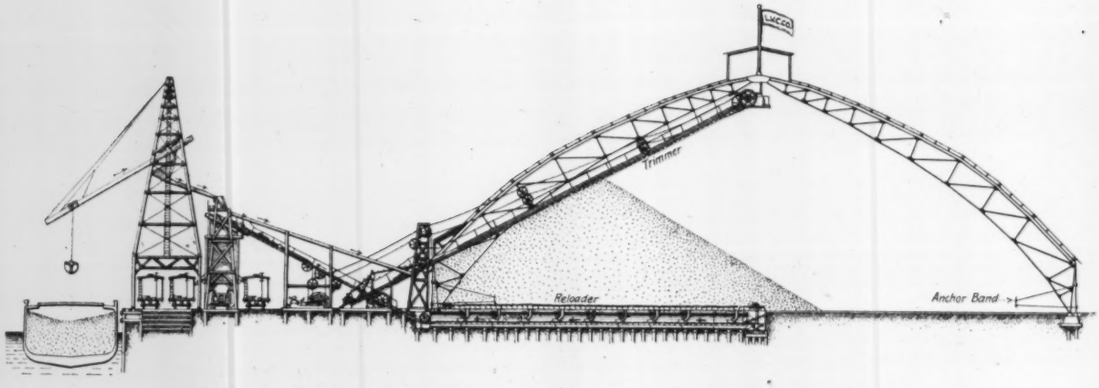


FIG. 2. SECTION OF ANTHRACITE PLANT, SHOWING METHOD OF OPERATION.

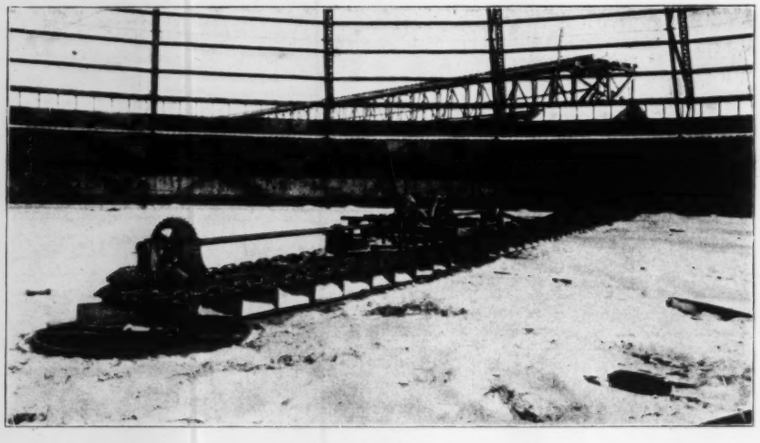


FIG. 3. VIEW SHOWING RELOADER, ANTHRACITE PLANT.

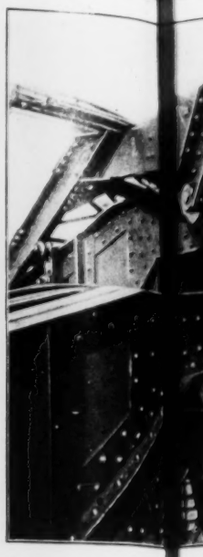


FIG. 5. VIEW SHOWING

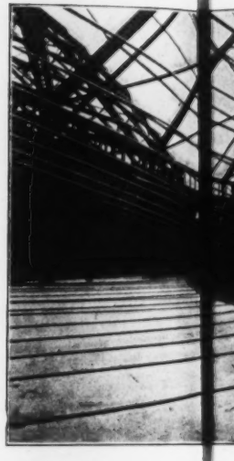


FIG. 8. VIEW SHOWING RET

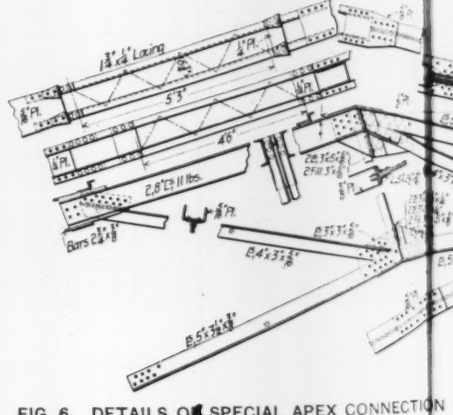
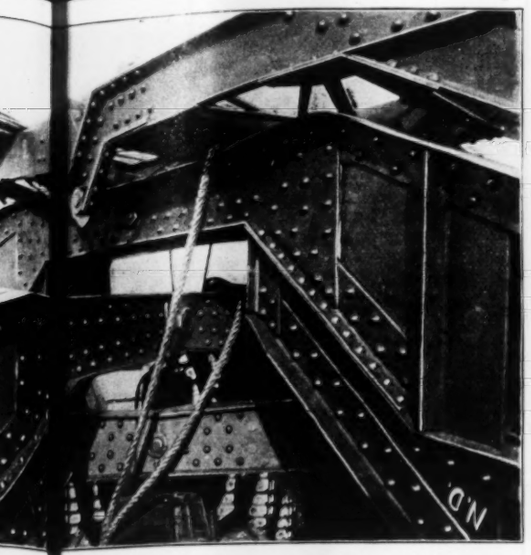


FIG. 6. DETAILS OF SPECIAL APEX CONNECTION PLANT.

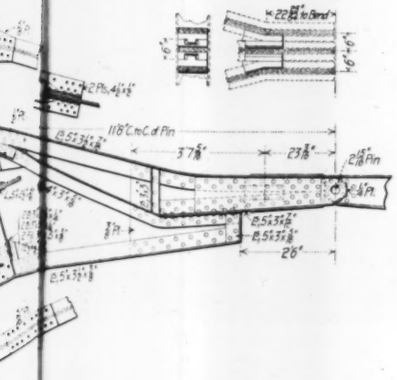
COAL STORAGE PLANT OF LEHIGH CO

Dodge Coal Storage Co., Phila



V SHOWING ROOF TRUSS CONNECTIONS AT APEX, ANTHRACITE PLANT.

OWING RETAINING WALL AND ANCHOR RING, ANTHRACITE PLANT.



ECTION FOR ROOF TRUSSES, ANTHRACITE ANT.

FIG. 4. VIEW SHOWING TRIMMER TRUSS, ANTHRACITE PLANT.

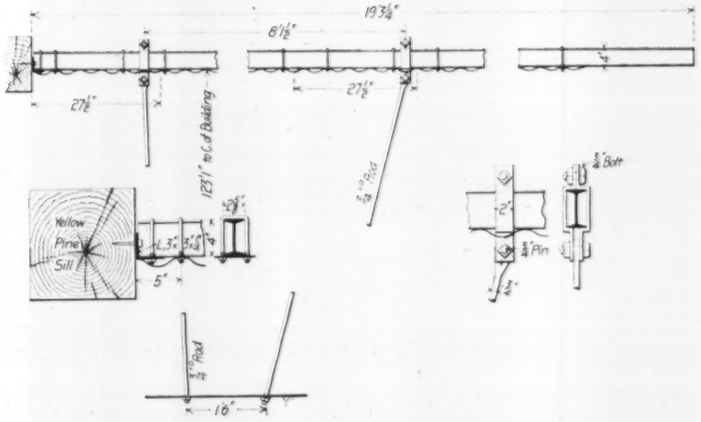


FIG. 7. DETAILS OF RETAINING WALL CONSTRUCTION, ANTHRACITE PLANT.

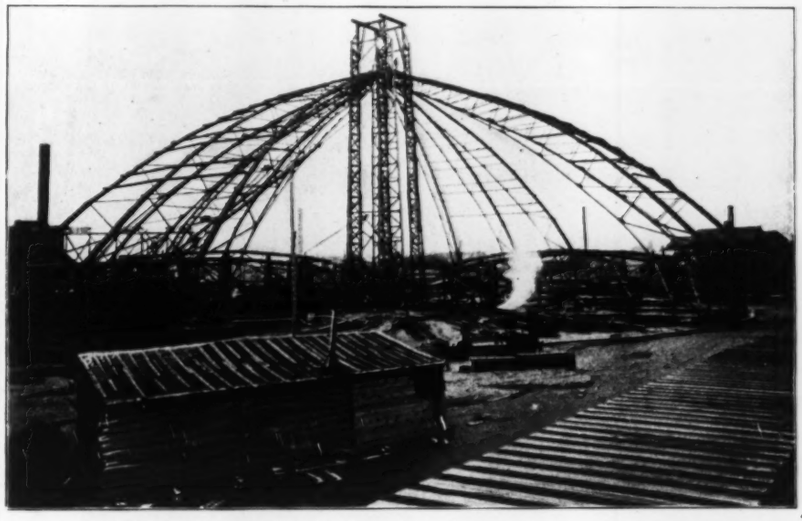


FIG. 9. VIEW SHOWING TOWER USED IN ERECTING ROOF TRUSSES, ANTHRACITE PLANT.

GH COAL CO., WEST SUPERIOR, WIS.

, Philadelphia, Pa., Designers.

bined with an unusual expansion of the cables by the very hot weather, threw an excessive compressive strain onto the cantilever portion of the stiffening trusses near the Brooklyn tower and caused the slight buckling of certain of the members. The damage done, while probably immaterial in itself, and certainly of no permanent injury to the supporting power of the bridge as a whole, was sufficient warning that the proper precautions in loading the bridge, which were so strongly recommended, should not be lightly neglected. The disposition of the surface railway companies to neglect these precautions is a perfectly natural one. Their object in crossing the bridge was for the purely business purpose of securing additional traffic and as much of it as possible. From the very beginning the increase has been more than they could accommodate even with great overcrowding during the rush hours, thus encouraging them to disregard any limitation set upon the number of cars which they could run. It is possible that these conditions will be somewhat altered when the elevated railway lines get their full quota of trains in operation across the bridge, and the constant pressure on the surface lines to overcrowd the bridge will be relieved. Whether this is the case or not, there can be no doubt that the bridge officials should see to it that the stipulations respecting the headway between the surface cars are properly observed, which they certainly have not done up to this time.

Municipal ownership of public service industries, in the interests of good government and public welfare, was the keynote of the meeting of the League of American Municipalities, recently held at Detroit. In the discussions of matters bearing upon this question, some important points were brought out which are frequently neglected or overlooked by zealous advocates of this system. These points accentuate the fact that municipal ownership is not necessarily a means of effecting good municipal government or the best relations between capital and labor. One point, which it is hardly within our province to discuss, was that municipal administration should be entirely independent of national or party politics. Another point was that without the civil service system, municipal ownership may be far less advantageous than corporate ownership. If the water or lighting plant is used as a political department, employment in which may be given as a reward for political services rendered to parties or persons, then the plant will almost certainly be operated with less efficiency and less economy than under corporate ownership, as it is at least to the financial interests of a company to keep men who are experienced in the work required of them. If employees are to be appointed, promoted or discharged without regard to merit, then municipal ownership will fail in one of its main purposes, and possibly in all. Still another point was that the class known as the "best citizens" must become something more than fault-finders, and must be prepared to take some active part in municipal affairs if any material improvement is to be made in municipal government. The financial interest of the average citizen in public affairs is small as compared with that of the professional politician, who looks to "politics" as a means of making money, and the latter has therefore a much greater incentive to devote his time to the public business of the municipality, although he does it in his own peculiar way, primarily for his personal benefit. At the present time, municipal administration is left very largely in the hands of men of this latter class. It was pointed out in the discussions referred to that the people of the United States are patriotic enough in time of war, and are willing to risk health, comfort, business, and even life, in the interests of their country. Good municipal government, however, requires patriotism enough in the quiet times of peace to make citizens ready to sacrifice some time and comfort in order that proper attention may be given to municipal affairs by men who work for the best interests of the public and the municipality rather than for merely selfish and personal interests. On the other hand, the idea of sacrifice is carried altogether too far in the demands made on and compensation given salaried officials whose services partake of a professional nature—engineers, city attorneys, health officers and commissioners of public works, where the latter are single-head commissions, with large executive functions. Such men should be sufficiently well paid to attract the best members of the respective classes from which they are drawn, to give dignity to their positions and to place them above the small temptations that lead to the first downward steps in the paths of bribery and corruption. The sacrifices, we urge, should not, as is now so common, be made by these public servants, who are expected to give all or the best part of their time to municipal service. Instead, they should be made (1) by every well-meaning and self-respecting citizen, through keeping himself properly informed regarding the affairs of his municipality and voting accordingly for or against every man and measure submitted to the suffrages of the people; and (2) the sacrifices should be made by the natural leaders of these same good citizens, in giving time to the shaping of public opinion and in serving on boards and commissions more or less honorary in character, it being understood that both routine and expert duties in connection with such commissions will be rendered by properly paid officials, engaged on the civil service plan where practicable.

THE VALUE OF EXTREME FINENESS OF GRINDING FOR HYDRAULIC CEMENT.

The extreme degree of fineness to which hydraulic cements are now required to be ground is a comparatively modern feature of cement specifications. Twenty years ago most cement users laid far greater stress upon the qualities of weight and color, which are now considered insignificant in comparison. When once engineers came to believe in the value of fine grinding, however, the progress made in developing this quality was very rapid. Cements which were regarded as finely ground ten years ago will not meet the standard requirements for fineness today, and the point has apparently not yet been reached where a still greater degree of fineness is not considered as an advantage. As an illustration, a well-known engineer has recently stated that in his opinion the point of fineness at which a cement was "really a cement and ceased to be sand" lay somewhere between a powder which would pass a sieve of 40,000 meshes and one which would pass a sieve of 160,000 meshes per sq. in. Few engineers, perhaps, would hold such an extreme degree of fineness essential, but the tendency everywhere, in Europe as well as in America, is, nevertheless, to place greater stress upon fine grinding and tests for fineness for Portland cement particularly.

It is reasonable to presume that this belief has not gained its popularity with engineers without some basis, and it may repay a little study to determine upon what particular merits for practical use extreme fineness has come to be considered a valuable quality for cement. Such a study will also be of value, we think, in shedding light upon the further problem whether it is desirable to continue the demand for still greater fineness of grinding, particularly such extreme degrees of fineness as those suggested by the figures just quoted.

At the very outset the generally accepted theory as to the inertness of the coarser particles of cement, as it is generally stated, needs to be corrected. By many recent writers on cement it has become the habit to class this coarse residue as practically inert. Some authorities even go so far as to regard it as a mere adulterant or as acting like so much sand. Such statements, when made without qualification, are entirely misleading. Experiments show that this coarse residue has a true cementitious value, of more or less amount, depending upon the size of the particles. Space will be taken here to quote only one of the most recent experiments in proof of this statement, but there are plenty of others which might be quoted with equal force. These figures are compiled from a series of tests made by Mr. David B. Butler, Assoc. M. Inst. C. E., and described by him in a paper published in the last volume of the "Proceedings" of the Institution, and they are as follows:

Portland Cement.

	Retained on 50 sieve.		Passed 50; ret. on 70		Passed 70; ret. on 120	
	6 mos.	12 mos.	6 mos.	12 mos.	6 mos.	12 mos.
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
A	150	160	200	200	250	330
B	95	120	110	160	175	200
C	90	120	140	170	190	280
D	90	140	115	197	192	200
E	..	180	190	292	330	420

The experiments show that compared with the fine, impalpable cement dust the coarse particles are evidently of greatly inferior cementitious value, but that they are not wholly inert. In fact, it would perhaps be better if they were, as will be shown further on. The fact obviously is that as the water is able to combine more readily with the fine than with the coarser particles, they set sooner and develop strength faster. Ultimately, the coarse particles also become hydrated and set and harden, but considerably after the fine dust has reached a somewhat permanent stage of hardness. The real objection to the coarse residue, if there is any, lies in this delay in its final hydration rather than in its inertness.

A further investigation of the figures presented by the experiments just quoted brings out this and a number of allied facts of significance. It appears from the accompanying table: (1) That the finer a cement is ground the more rapidly it sets, and, somewhat less certainly, (2) that finer grinding seems to correct any tendency to unsoundness. Both of these conclusions are corroborated by previous French and German experimenters and are not really new, but they illustrate the two facts which it seems needful to emphasize here.

If a finer grinding of cement corrects a tendency to "blow," it is evidently a most important thing for engineers to know. That it does do this seems open to very little doubt, and it may be readily explained, we think, why it should. One of the most prolific causes of "blowing" in cement is quite generally admitted to be an excess of uncombined lime. The hydration of this lime causes expansion whether a cement is fine or coarse, but in the finely ground powder the hydration takes place during gaging, owing to the ease with which the water gets access to the almost impalpable grains, and the expansion is

Table Showing Effect of Fineness Upon Time of Setting: Rise in Temperature During Setting, and Soundness.

Cement.	Condition.	Per cent. residue on sieves of 180.	76.	50.	Time of setting, Initial, mins.	Hard, mins.	Increase of temperature during setting, °F.	mins.	Return to normal temperature, mins.	Faija hot water test.
J.	Normal	22.4	6	0	25	45	22 in	40	120	Sound.
"	Reground	Trace.	0	0	1	5	38 "	5	90	"
K.	Normal	26 6	10	2.7	30	90	17 "	100	240	"
"	Reground	Trace.	0	0	6	15	32 "	11	150	"
L.	Normal	24.4	7.6	1.5	30	120	9 "	60	180	Blown.
"	Reground	Trace.	0	0	7	15	29 "	13	120	Sound.
M.	Normal	30	6.7	1.2	20	60	21 "	34	150	"
"	Reground	Trace.	0	0	2	10	26 "	8	75	"
N.	Normal	28.4	9.3	1	15	30	25 "	21	120	"
"	Reground	0.6	0	0	1	10	32 "	4	120	"
O.	Normal	26.4	7.7	0.5	(1)	360	2 "	39	160	"
"	Reground	0.4	0	0	8	25	27 "	12	95	"
P.	Normal	18	3	*0.8	15	240	15 "	23	120	Badly blown.
"	Reground	0.4	0	0	2	240	23 "	5	100	Slightly blown.
	2% gypsum	18	3	0.8	(1)	1,440	1 "	15	35	Blown.
Q.*	Normal	34.8	16	3.6	20	30	17 "	35	180	Badly blown.
"	Reground	1.6	0	0	2	5	26 "	5	180	Sound.
"	2% gypsum	34.8	16	3.6	(1)	1,440	1 "	15	30	Blown.

(1)Time of initial set indefinable.
*A specially prepared over-limed cement.

immediate and uniform and does no damage. In the coarse powder, on the contrary, the uncombined lime in the interior of the particles does not hydrate, and consequently expand until the surrounding finer grains have set and thus swelling and cracking results; or, in other words, the cement "blows."

That the foregoing explanation covers all the causes of unsoundness in cements no one will contend for a moment, but it does give a reason, we think, why a very finely ground cement shows less tendency to "blow" than the same cement coarsely ground. It indicates, furthermore, that in holding the theory that the coarser residue is inert we neglect a possible source of danger. If the coarse particles were really inert, like so much sand, for instance, they would not be acted upon at all by water. All the effect they could possibly have would be to make the hardened cement more porous and thus allow the freer entrance of disruptive elements into the cement stone. The great importance of this feature of porosity was fully discussed in Engineering News of July 29, 1897, and need not be alluded to further here.

The evidence deduced so far, while it is not so conclusive as one could wish, tends on the whole to show that it is not the inertness, but the activity of the coarse residue, that makes it most undesirable. If inertness were the only charge against the coarse residue, the moderate percentage of coarse material would be of no great importance. About the only disadvantage resulting would be a reduction in the ability of the cement to take sand. The hardening of a finer cement mixed neat is more rapid, but it attains less final strength than when more coarsely ground.

The effect of fine grinding upon the setting properties of cement is also an important matter to be kept in mind. The tendency of engineers to-day seems to be to call for slower setting cements as well as finer grinding. The figures given in the table and corroborated by other experiments indicate pretty certainly that these qualities are antagonistic to each other, and if engineers persist in demanding both something must be done by the manufacturer to modify this antagonism. The question is, what will it be? Aeration will usually render the cement slower setting, but this is a process which takes time and labor to accomplish properly, and in the rush of manufacture and construction work it is likely to be neglected for some easier method. The danger is that adulterants may be employed.

By adding a small percentage of ground gypsum to the cement the figures given in the table show that the rate of setting is materially retarded. They also show that the tendency to blow is increased. This form of adulteration is mentioned particularly because it is already largely practiced in Germany. In fact, the addition of not over 2 per cent. of powdered gypsum to Portland cement is sanctioned by the German Cement Manufacturers' Association. Several high authorities maintain, however, that the addition of gypsum should never be sanctioned where cement is to be used in sea water, and experiments recently made show that the addition of 5 per cent. of gypsum causes decided disintegration. Even if the addition of 2 per cent. of gypsum is allowable, it is evidently very easy to overstep the mark. Until, then, the ultimate effect of adding gypsum to retard the rate of setting is more fully investigated it seems the part of wisdom to regard it with suspicion.

The next feature of extreme fineness of grinding which is of most particular interest to engineers is its effect upon the strength of cement. Fortunately, the evidence is so complete upon this point that it can be quickly dismissed. Gaged neat, as already stated, a very fine cement is stronger at early ages and weaker at great ages than a cement more coarsely ground. Mixed into mortar with sand, however, the superior strength of a fine cement over a coarser cement is very evident, at least in the earlier periods of hardening. A mortar high in sand exhibits this value of fine grinding more, however, than a mortar low in sand. In many cases a very rich mortar made with a coarse cement reaches nearly the same ultimate strength as when made with a very fine cement. The attainment of extreme fineness may not always, therefore, be economical when the extra cost of fine grinding is considered. This bears directly upon the inquiry already suggested, whether such extreme fineness as powder which will all pass a 40,000 mesh sieve is practically worth attaining.

There is much to be said upon this question and space can be taken here only to suggest a few of the most prominent considerations. It seems likely first of all that to produce regularly a cement finer than will pass a 40,000 mesh sieve means considerably increased cost in manufacture. As a single illustration, manufacturers question whether mechanical screening is practicable where screens finer than 200 meshes per lineal inch are required, and if finer grinding is required some new method of separating the sufficiently fine from the coarse powder must be devised. Doubtless, such a method can be devised, but can it be done without increasing the cost? This is a fact not yet determined. The further problem of too rapid setting because of such very fine grinding is also yet to be solved. When, however, these questions are finally settled there is still another to be decided. May it not be cheaper to develop a certain strength of mortar by using a coarse cement low in sand than by using a fine cement high in sand? We know for a fact that this is true of many similar cases. It is cheaper, for instance, to attain a certain strength of mortar or concrete in some cases by using a rich natural cement mixture than it is by using a poor Portland cement mixture. The case of using a fine or a coarse cement is quite similar.

To summarize what has been said we may conclude: (1) The coarser particles of cement are not inert but have a certain cementitious value approximately in inverse ratio to their size, and because of this activity introduce an element of danger from blowing; (2) the extreme fine grinding of cement decreases its cohesive strength, but immensely increases its adhesive strength, and, consequently, its value as cement, but the attainment of extreme fineness may not always be economical in practical construction, owing to the extra cost of fine grinding; (3) the finer grinding of cement greatly hastens its value of setting and may introduce the necessity of using adulterants or other artificial means of retardation; (4) finer grinding seems to correct a tendency to unsoundness by allowing the water to attack the uncombined lime during gaging instead of after setting, as is the case when it is confined within the coarse particles.

On the whole, these conclusions demonstrate the advantage of fine grinding. They bring out clearly, however, that this merit is not entirely unalloyed with disadvantages. This is the truth which we have wished especially to emphasize in this brief discussion, for the reason that in many instances it has seemed to us that the greatly superior strengths shown by fine cements over coarse cements in short-time neat cement tests has led cement users to grant them superiority on that evidence alone. As we pointed out in our issue of July 28, high short-time tests are likely to be overestimated in practical value if good judgment is not exercised. Fineness of grinding considered from the point of view of strength alone involves a similar danger.

In conclusion, attention may be directed to the figures in the accompanying table, which show the relation between the rise in temperature of cement during setting and its soundness. Some authorities, as is well known, have advocated this rise in temperature as a test for soundness. The figures in the table do not support this theory. In fact, they show that this evolution of heat bears a distinct relation to the time occupied in setting. To require that a cement shall show little or no rise in temperature during setting ensures an extremely slow setting cement but does not guard against an unsound one.

LETTERS TO THE EDITOR.

Report on the Condition of the Paints on the 155th St. Viaduct, New York City.

Sir: We have read in Engineering News of July 28, Mr. Henry B. Seaman's comment on your editorial of July 21, in which, referring to the paints used on the 155th St. Viaduct, he says: "All the paints used in this test were patented paints." We wish to take exception to this statement, as Dixon's Silica-Graphite Paint was one of the paints used, and it is neither patented nor a compound. The name silica-graphite fully designates what the pigment is, namely, silica and graphite. The silica is not silicate of alumina, as some have wrongly supposed, but is, practically speaking, a pure silica ground to an impalpable degree of fineness. The graphite is not one of the amorphous forms of graphite, nor is it of the soft Ceylon variety; it is a hard, tough, flake graphite which comes from the famous Ticonderoga mines in New York state, which are owned by the Dixon company. Graphite paints, to possess the greatest durability, so far as the pigment is concerned, must be made of the toughest and best form of graphite, and graphite varies greatly.

Yours very truly,
Jos. Dixon Crucible Co.

Jersey City, N. J., Aug. 10, 1898.

The "Arithmetic of the Steam Engine" Again.

Sir: Waiving all further discussion of those points relating to sensible heat, horse-power, etc., about which we appear to differ, I would beg a few more lines of space to defend the position regarding energy, momentum and vis viva which I have taken in the little volume that has given rise to this correspondence.

To begin at the beginning, everything connected with these subjects starts from the well-known relation which, derived from actual experiment, governs the movements of heavy bodies acted upon by a constant accelerating force, namely:

$$v = a\,t. \qquad (1)$$

In which relation v = velocity in feet per second at a given instant; t = corresponding time of action in seconds, and a = acceleration due to constant force in feet per second, per second. From (1) we derive:

$$t = \frac{v}{a}$$

Multiplying both sides of the equation by $\frac{v}{2}$

$$\frac{t\,v}{2} = \frac{v^2}{2\,a}$$

Now $\frac{v}{2}$ = mean velocity of a body moving from rest under the influence of the acceleration, a, at the instant when its velocity = v. But time into mean velocity = distance covered during the given time, hence the next above equation becomes:

$$h = \frac{v^2}{2\,a}, \qquad (2)$$

In which equation h = distance traveled in given time t. The element of time disappears from this equation.

The acceleration due to terrestrial gravitation being represented by g, (1) and (2) become for the special case of heavy bodies falling upon the surface of the earth:

$$v = g\,t. \qquad (3)$$

$$h = \frac{v^2}{2\,g}. \qquad (4)$$

According to the second clause of Newton's second law of motion, as quoted by Jamieson, "The change in the quantity of motion is therefore proportional to the force applied, and takes place in the direction of that force." Hence, the corollary of primary significance in dynamics—"Constant or uniform forces acting freely upon heavy bodies impart to such bodies accelerations proportional to the intensities of the forces themselves." (Arithmetic of the Steam Engine. p. 61.) This law enables us to measure the intensity of forces imparting given accelerations to bodies possessing certain weights, by comparing these accelerations to the acceleration imparted by gravity. The law may be thus stated: A force, F, imparting an acceleration (or retardation), a, to a body of weight, W, is to such weight as a is to g. Or, expressed as an equation:

$$\frac{F}{W} = \frac{a}{g}. \qquad (5)$$

Which reads: Force is to weight as acceleration is to 32.2.

These elementary preliminaries being established, let us revert to our formulae (1) to (5). From (1), we have:

$$a = \frac{v}{t}$$

Substituting this value of a in (5) gives:

$$F\,t = \frac{W\,v}{g}. \qquad (6)$$

This is the formula of momentum, and it gives the steady force, F, necessary to communicate or extinguish the stored energy of a body of weight, W, moving with a velocity, v, in the time, t, which elapses before the body comes to a state of rest.

Multiplying both sides of (6) by $\frac{v}{2}$, gives:

$$\frac{F\,t\,v}{2} = \frac{W\,v^2}{2\,g}$$

But we have already seen that $\frac{t\,v}{2} = h$. Therefore,

$$F\,h = \frac{W\,V^2}{2\,g}. \qquad (7)$$

This is the formula for vis viva, and it gives the steady force, F, necessary to communicate or extinguish the stored energy of a body of weight, W, moving with a velocity, v, in the distance, h, traversed by the body before coming to a state of rest.

Every heavy body moving with a certain velocity has stored within it, in virtue of its property of inertia, a certain amount of energy depending upon its weight and velocity. We estimate this energy by the force necessary to produce or destroy it. The right hand member of (6) represents the passive force, F, necessary to destroy the energy stored in a body of weight, W, moving with the velocity, v, in one second of time. The left hand member is the product of the force and any given time necessary to accomplish the same result. Note, as bearing upon your previous criticism, that the left hand member is simply "weight into time." The necessary element of motion is only to be found in the right hand member.

The right hand member of (7) represents the passive force, F, necessary to destroy the stored energy in the distance of one foot, assuming throughout English units. The left hand member is the product of the force and any given distance necessary to accomplish the same result. Note again that the left hand member of (7) is "weight into distance."

An illustration: A flywheel rotating with a certain velocity contains a certain amount of energy stored in its rim. If steam be suddenly shut off and a steady, stationary force of a certain number of pounds be applied to the brake-drum, the stored energy will be gradually extinguished and the wheel will stop in a certain number of seconds. During that time it will perform a certain number of revolutions before coming to a stop. The energy stored in the wheel is the same, and the force applied to the break is the same, and we can estimate the amount of energy neutralized by the given force, neglecting other resistances, either in terms of time, when it becomes a problem in momentum, or in terms of distance, when it becomes one of vis viva. This is why I said in my book that "Momentum represents the stored or acquired energy of weight acting through time," and that "Vis viva represents the stored or acquired energy of weight acting through distance."

No exposition of mathematical principles is complete without a numerical example. Let us add a little to the data of your example of a ship weighing 10,000 tons, acted upon by a weight of 1 lb. for a period of 100 seconds, so as to make it amenable to calculation, and let us suppose that the ship has been moving with a certain steady velocity, V, when the propelling force is suddenly withdrawn and she forges ahead in virtue of her inertia, until stopped by the steady resistance of 1 lb. applied for a period of 100 seconds. With what velocity was she moving, and in what distance did she stop? Reducing the tons to pounds and applying (6) we have:

$$V = \frac{1 \times 100 \times 32.2}{20000000} = 0.000161 \text{ ft. per second.}$$

As for the distance traveled before stopping, we have above her initial velocity, which was gradually reduced to zero. Her mean velocity was therefore one-half of the above, or 0,0000805 feet per second, and it was maintained for 100 seconds. Hence the required distance is 0,00805 feet. This result can also be obtained directly by using (7). This example is, of course, fanciful, but it serves the purpose of illustration.

It will be noted that in all the above illustrations the stored energy only has been considered. In the case of a locomotive running with a certain regular speed the resistances offered only prevent an increase of velocity. If the steam be shut off, they overcome the stored energy and bring the machine to a stop. When speed is maintained against resistance, the problem is one of work and neither of momentum nor vis viva.

I could not explain all this so fully in my little book without sacrifice of brevity. I believe, however, that the subject is of sufficient importance to render the above elucidation of interest and possibly of utility to many of your readers.

Very faithfully yours,

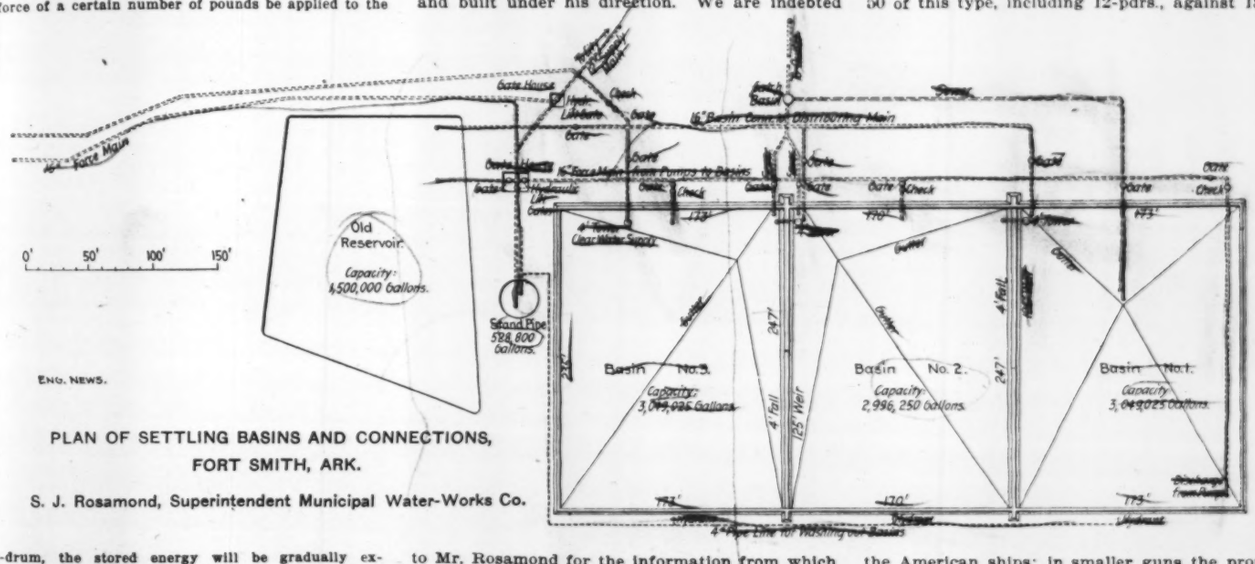
E. Sherman Gould.

Yonkers, N. Y., Aug. 1, 1898.

(We give place to Mr. Gould's letter, and will say that our difference with him relates practically only to the definition of the terms energy, momentum and vis viva. The last-named term we consider and obsolete one.—Ed.)

THE NEW SETTLING AND AERATING BASINS, FORT SMITH, ARK.

Three new settling basins, with a combined capacity of about 9,000,000 gallons, were put in operation at Fort Smith, Ark., in November, 1897. They were designed by Mr. S. J. Rosamond, Superintendent of the Municipal Water-Works Co., and built under his direction. We are indebted to Mr. Rosamond for the information from which our description of the basins has been prepared.



PLAN OF SETTLING BASINS AND CONNECTIONS, FORT SMITH, ARK.

S. J. Rosamond, Superintendent Municipal Water-Works Co.

Fort Smith had a population of 11,311 by the U. S. Census of 1890, and of 20,100 by the directory census of 1898. The water-works were built in 1884. The supply is pumped from the Poteau River, to a stand-pipe and direct and also to settling basins. Besides the settling basins there is an old reservoir with a capacity of 1,500,000 gallons.

The old and new basins, the stand-pipe and connections are shown in plan by the accompanying illustration. The pumping station is about 2,500 ft. from the old basin.

The bottom of the new basins is solid rock, covered with 2 ins. of cement mortar. The basins are so located on sloping ground as to give a fall of 4 ft. from No. 1 into No. 2, and from the latter into No. 3. Advantage is taken of this to aerate the water by passing it over weirs, now stopped off to a length of 75 ft., but with a full length of 125 ft. for use when the consumption increases. Clear water may be drawn from any one of the three basins through a tower 4 ft. in diameter, and 15, 14 and 10 ft. in height for basins Nos. 1, 2 and 3, respectively. These towers are of ¼-in. wrought iron, and are provided with inlets at different levels so the water may be drawn from the top, middle or bottom of the basin, if desired; generally it will be drawn from the top.

The average water consumption is about 2,000,000 gallons a day in summer. The Poteau River, from which the supply is taken, is quite turbid at times. The settling basins, Mr. Rosamond states, have given satisfactory results. He also says that the stand-pipe is filled only when the river is clear, and is always drawn upon for fires, the direct pressure being reserved for emergencies. In case of an exceptional demand it might be necessary to use water without sedimentation, but probably this occurs only at long intervals.

GUN-FIRE ANALYSIS OF THE SANTIAGO SEA-FIGHT.

The gun-fire is analyzed, for the Santiago sea-fight of July 3, by Lieut. B. W. Wells, Flag Secretary for Commodore Schley. The total number of guns on the seven American and six Spanish ships engaged is given in detail as follows:

United States. Caliber.	No. guns.	Spanish. Caliber.	No. guns.
13-in. B. L.	8	11-in. B. L.	6
12-in. B. L.	6	6-in. R. F.	10
8-in. B. L.	32	5.5-in. R. F.	30
6-in. B. L.	14	4.7-in. R. F.	6
5-in. R. F.	12	12-pdrs.	4
4-in. R. F.	6	6-pdrs.	38
6-pdrs.	90	1-pdrs.	10
1-pdrs.	28	Maxim-Nordenfeldt	4
Maxim-Nordenfeldt	3	Hontoria 37-mm.	24
Machine guns	26	Machine guns	14
Total	225	Total	146

While the United States had fourteen 13-in. and 12-in. guns, only two shots from these struck the enemy's ships. In rapid-fire guns the Spanish had 50 of this type, including 12-pdrs., against 18 on the American ships; in smaller guns the proportions were 131 on the U. S. ships to 76 on the Spanish ships, omitting machine guns. The accurately destructive fire of these small guns on the American ships drove the Spanish from their guns; though the 8-in. American fire probably did the most serious damage.

When the Spanish ships left the harbor they headed westward and brought their full port batteries to bear; while the American ships were closing in bows-on. As a result, the following table gives a fair estimate of the number of guns engaged on each side:

United States. Caliber.	No. guns.	Spanish. Caliber.	No. guns.
13-in.	4	11-in.	6
12-in.	4	6-in. R. F.	5
8-in.	32	5.5-in. R. F.	15
6-in.	7	4.7-in. R. F.	3
5-in. R. F.	6	12-pdrs.	4
4-in. R. F.	3	6-pdrs.	21
6-pdrs.	47	1-pdrs.	5
3-pdrs.	4	Hontoria 37-mm.	21
1-pdrs.	4	Maxim-Nordenfeldt	4
Machine guns	8	Machine guns	7
Total	119	Total	91

To determine the metal thrown per minute, says Lieut. Wells, take the time allowed from fire to fire for the 13-in. gun as a unit. Then in that length of time the weight of metal from the 13-in. guns would be 4,400 lbs. The allowed time from fire to fire for the 13-in. is 320 seconds, and for the 12-in. it is 300 seconds, hence the weight of metal thrown by the 12-in. in 320 seconds is 3,613 lbs. These quantities for other calibers are found similarly; hence we have:

Guns.	Metal, lbs.	Guns.	Metal, lbs.
13-in.	4,400	4-in. R. F.	1,584
12-in.	3,613	6-pdrs.	7,520
8-in.	12,000	3-pdrs.	384
6-in.	1,778	1-pdrs.	1,720
5-in. R. F.	3,840		
Total weight thrown in 320 seconds, lbs.			35,839
Weight thrown per minute, lbs.			6,720

In determining this quantity for the Spanish guns the same time allowances are used as for similar types of United States guns. The weights of projectiles are for common shell, and have been ascertained as nearly as possible. The time unit is 300 seconds, being the interval from fire to fire of the United States 12-in. gun.

Guns.	Metal, lbs.	Guns.	Metal, lbs.
11-in.	3,516	4.7-in. R. F.	1,584
6-in.	3,750	6-pdrs.	3,150
5.5-in. R. F.	10,277	1-pdrs.	900
12-pdrs.	800	Maxim-Nordenfeldt ...	300
Total weight thrown in 300 seconds, lbs.			24,133
Weight thrown per minute, lbs.			4,827

Machine guns are omitted.

It will be noted that the weights thrown per minute were as 6,720 to 4,827; this is approximately as 139 to 100. Therefore the fire of the United States ships, instead of being treble that of the Spanish ships, was one-third greater, and this small difference could not alone account for the disparity in results.

Lieut. Wells concludes that the victory was due, in part, to the following causes:

1. The greater accuracy of fire of the United States vessels.

2. The use of wood in the Spanish ships to such an extent as to render the extinguishing of a fire practically impossible after several large shells had cut up water mains and hose.

3. The greater number of guns of 8-in. caliber on the United States ships.

4. The better morale due to the fact that all the crews had been under fire a number of times during bombardments along the Cuban coast at Santiago de Cuba and at San Juan.

5. The value of a large secondary battery was demonstrated, for the work of the 6-pdrs. contributed largely in keeping down the enemy's fire by driving them from their guns.

6. The necessity for more and better protection for the gun's crews. With the men disabled or driven from their stations, the ship is of little value as a fighting machine. The armor of the "Colon" kept out 5-in. shells at a range of about 3,000 yds. This would be a very great superiority in many cases.

7. The small danger of injury to the water-line portions of the ships. So far as is known, no vessel was penetrated between wind and water. Moderate armor protection at the water-line, with a strong protective deck, would permit a more efficient distribution of the armor around the gun positions.

A HIGHER INDUSTRIAL AND COMMERCIAL EDUCATION.*

The material prosperity of any country is the foundation of the happiness and of the progressive enlightment of its people. To learn the essential conditions of such a prosperity, therefore, is a matter of supreme importance. In the former times, all knowledge of material things was traditional, and had to be learned by the traditional methods; to-day nearly all knowledge is scientific, and should be acquired by scientific methods. Formerly the industries were directed by mechanics, who by a long apprenticeship had slowly acquired the manual methods of their predecessors; to-day they are most successfully guided by men of large scientific attainments; and in the near future such scientific direction will be absolutely essential wherever there is free competition in the market to be supplied. Prosperity, or even supremacy, in material things in the past, is, therefore, no promise of such a position in the future, and as a proof of this, we have but to compare the past achievements of England and its present subordination to Germany.

That an interior country like Germany, without a navy, and with little foreign commerce, could in a quarter of a century increase her manufacturing capacity ten-fold and make it equal to that of England;* increase her shipping twenty-fold, making it second to that of England; effectually establish a regular export trade with every country on the globe, and by at once cheapening products and improving their quality, put herself in a position to hold these markets indefinitely; that all this could be accomplished in the face of open competition, and in this age of universal publicity, is indeed marvelous and would alone prove that old methods have lost their potency, and that something new has arisen under the sun.

When we seek an explanation of these wonderful achievements we find only a rational and provident application of means to ends, but on the most gigantic scale and persevered in far more consistently than has ever before been even planned, to say nothing of the execution. It is evident that the efficient direction of any industry to-day demands a very large amount of technical knowledge which cannot be learned at the bench or in the shops. While self-education is always possible, the obstacles are commonly prohibitive, and at best the results are meagre and unsatisfactory. Germany has seen this situation most clearly, and it is to her clear conception of this problem, and her rational and thorough solution of it, that has raised her industrially from poverty and obscurity to wealth and fame in the short period of a quarter of a century.

The German Mono-technic Schools.

Seeing that the capacity for production is limited only by the intelligence and foresight of a people, and that there is a rapidly growing and prospectively unlimited demand for all kinds of artistically manufactured goods, Germany set to work some twenty-five years ago to supply this demand by the intelligently directed labors of her own people. This country had long been the home of classical and military learning, but it now became also the very center and head of technical and industrial education. The members of this society are all quite familiar with her high-grade engineering schools, but we are not so familiar with her industrial schools. In fact, we have commonly spoken of these with more or less indifference, calling them trade-schools. We have assumed that the difference between them and the engineering schools was one of kind, rather than of quality or degree. As a result of some recent study of the leading industrial schools in Germany, I am inclined to question the justice of our position. Since the sciences of mathematics, of physics, of electricity, of chemistry, of mechanics, of steam engineering, and of the materials employed, enter so largely into all these school courses, they are, in fact, schools of applied science, and they now pass in Germany under the very appropriate name of mono-technic schools. Such schools are there found for all the leading industries of the empire, and there are many schools for the same industry. Thus there are in Germany 13 schools devoted to the textile industries, each with its peculiar organization specially adapted to the region in which it is placed. As little duplication as posible is practiced, and when the same field is covered in two or more schools, variations in methods are introduced for the purpose of comparing results. The students entering these schools have first to complete the course of study in the "Real Schools" (or say, through the sophomore year of our engineering schools), and then the course of study in the mono-technic schools is three years of 45 hours a week, on the successful completion of which certificates are granted.

The fine and costly buildings in which these schools are installed; their elaborate equipment with all the needful chemical and physical laboratories, and machinery to convert them into regular commercial factories; their large corps of trained teachers, and the very small number of students admitted to take their full courses; the administrative care and oversight given to them, and their very small tuition fees, all serve to make the training given in them extraordianrily expensive to the state. Thus the textile schools of Crefeld had last year only 108 regular day students in the weaving school, and 40 in the dyeing and finishing school. In the weaving school was the director with 15 assistant lecturers, and six other assistants; in the dyeing and finishing school there were the director and three assistant lecturers, a special chemist for dyeing and for finishing, or a force of 29 instructors for 146 regular students. There were, however, irregular students in attendance on night and Sunday courses. The plant of this school included extended chemical and physical laboratories fully equipped, drawing rooms, lecture and testing rooms, chemical museum, library and reading rooms. The mechanical equipment was that of a complete weaving, dyeing and finishing works, for all the finer grades of woolen and silk goods. Commercial work is done on a large scale, the students doing the work under the direction of the assistants. Specially difficult tasks in dyeing are here undertaken and successfully accomplished, and regular consignments of this character are made by some of the leading factories of the empire.

This school is only one of hundreds in Germany which are training up a class of men for the direction of all kinds of commercial works in which scientific knowledge is finding its embodiment and application. As a result of this training we find such great industries as the Aniline and Soda works at Ludwigshafen on the Rhine, which has grown from employing a total force in 1865 of 30 people to employing 5,000 men and over a hundred trained chemists in 1897. Also the optical and electrical works of Schuckert & Co., at Nuremberg, which started on a very small scale in 1882, but which now employs over 4,000 men, besides a large scientific staff, and which had in 1897 unexecuted orders on hand aggregating $15,000,000. Three-fourths of of all the coloring matters and pharmaceutical products now produced from coal tar is made in Germany, their total annual products of this class aggregating $40,000,000. The earliest chemical discoveries of these products were made in England, but there was not sufficient knowledge of applied chemistry in that country to utilize these discoveries.* It is such examples as these, of which there are many, that indicate that Germany is reaping the fruits of the painstaking and farseeing policy she has entered upon, and if other nations wish to share her prosperity, they must act with a like wisdom and determination. The proof that Germany's remarkable industrial prosperity is traceable very largely to her educational methods† is so patent to the people themselves that they voluntarily unite to support schools in their particular trades. Thus of the 248 mono-technic schools in Prussia alone, which are so supported, the painters and decorators have 32; the shoemakers, 9; the tailors, 16; the bakers, 20; the butchers, 6; the smiths, 26, and so on.

Every trade has its own school aside from those supported by the state and by the municipalities. The artisans themselves see that systematic and scientific teaching entirely outclasses the old apprenticeship system, and these schools are constantly multiplying. In Saxony alone, there are 111 of these mono-technic schools, besides ten schools of agriculture and 40 of commerce. In the Grand Duchy of Hesse, with a million inhabitants, there are schools of agriculture and sculpture, nine schools for artisans, 43 for industries, and 82 schools of design. The Grand Duchy of Baden, with 1,600,000 inhabitants, supports schools of industry, architecture, commerce, clock-making, cabinet-work and music, with an annual expenditure of $280,000. In addition to these schools peripatetic teachers are employed to go from house to house to instruct in embroidery and the use of the sewing machine, the state selling these machines at a greatly reduced cost on condition that the purchaser shall explain its workings to her neighbors. In fact, Germany, as viewed from without, would seem to be in the throes of a kind of educational fever. No doubt a large part of this educational work has been necessary as a result of the very backward condition of the common people along these lines, and to such an extent these methods could not find a place in this country, but aside and beyond these limits may we not see in the example of Germany the royal road to industrial prosperity? While the industrious character of the people, the military spirit which pervades all her industrial and commercial affairs as well as the military department; the absolute stability of her governmental policy and the fixedness of her currency and financial basis; and the disposition to be satisfied with small wages and profits so long as these both rest on a sure and permanent footing; while all these certainly contribute largely to her present material prosperity, these same advantages are also held with her in common by some other countries which are not, however, sharing her present prosperity. The tremendous military budget of Germany cuts deeply into her productive profits, so that without this her commercial advancement would have been still more marked. It is not her army of soldiers, however, which other nations need to fear, but her army of scientifically trained directors of industrial enterprises, and of the highly educated commercial agents, at which they may well tremble.

But Germany not only educates the men who manufacture, but she is also beginning to look well to the training of the men who are to carry their goods to the ends of the earth and report back the peculiar needs of every locality. Schools of commerce are being organized, modeled after those of France and Belgium, in which in addition to what is taught in our "commercial colleges," will be found a speaking and writing acquaintance with several foreign languages, especially English, Spanish and French, if these have not already been acquired; political economy; industrial and patent laws; railroading; shipping; postal and telegraph regulations; banking, exchange, coinage and national schemes of finance; industrial history; commercial geography, etc. A German National conference was held on this subject a year ago, and a new system of commercial education is now being established all over the empire. Modern languages form a part of the elementary school training, especially English, so that the entering students in these schools are likely to be well equipped in this particular. With such material as these schools will turn out, their students coming from the better mercantile classes, and having the manners and bearings of gentlemen, the large manufacturing and mercantile houses can establish branches in all the leading foreign countries, and with the system of foreign German banks, which are even now found everywhere, the conditions are ripe for the ready and rapid sale of German products in all parts of the world. From a remarkable publication by Mr. Frederick Emory, just issued from the Bureau of Foreign Commerce of our State Department, on the recent increase in our foreign trade, and in reference to the necessity for the individual manufacturer and merchant to study carefully the trade conditions in foreign countries, I quote:

Nor is it with the relation of the different nations to one another that we are alone concerned. The industrial changes current within the territory of each obtain a new and much graver importance in their possible effect upon our nascent development as an exporter of manufactured goods. The conditions contributing to the rapid growth of manufacturers in recent years; the fiscal changes in Russia, India and Japan as well as in some of the Latin-

*Abstract of the Presidential address of J. B. Johnson, M. Am. Soc. C. E., before the Society for the Promotion of Engineering Education, Boston, Aug. 18, 1898.

*See Mulhall's Industries and Wealth of Nations, 1896.

*Report of Technical Instruction Committee, City of Manchester, England, 1897, page 12.

†This is universally acknowledged by all who have examined into her system. See English Consular Report, No. 2,046, entitled, "Trade in Germany," April, 1898.

American countries; the extraordinary impulse given to the industrial growth of the German Empire as a factor of international trade; the advance of Russia on similar lines; the rapid progress of the Siberian Railroads toward an open port on the Yellow Sea; the efforts of Great Britain to meet the encroachments of other nations; the decline of the sugar industry in the West Indies as a result of the beet-sugar competition; the troubles of Spain with her colonies; the discovery of gold in Alaska and the adjacent territories in British Columbia; the tariff legislation of the United States, Canada and other countries; all the phases of economic changes during the past year, have an interest and importance for the individual operative in the United States which are greatly enhanced by the transformation now going on in our industrial life, converting us slowly but surely from a people absorbed with the internal development of a virgin continent into one of the great commercial powers of the world, with the international interests and responsibilities which such a position naturally applies.

Evidently in order to keep abreast of all such changes which are constantly going on the world over, a special class of highly trained men are required. And here too, the supply of such a new and improved kind of clerical assistance would at once create its own demand.

It would seem the time is now ripe in this country for the establishment of such schools. They are needed as much or more for the training of our foreign consuls as for the commercial agents of the large business houses and industrial establishments.* In France there are eleven of these high-grade colleges of commerce.†

The course of study in these colleges of commerce is two years, with a preparatory year, all of 33 lecture hours a week. The following is a brief outline of the distribution of this time, the minimum age being 16 years, which is predicated upon about our college entrance conditions, to which has been added in the preparatory year about all that is taught in our American so-called commercial colleges:

Distribution of Time in the French Colleges of Commerce.
(Time two years.)

11 hours per week to Commercial Methods and Transactions in what is called the commercial bureau.
3 hours of Commercial Geography.
1 hour of the History of Commerce.
2 hours to a study of Commercial Products, involving the actual handling of the materials.
2 hours to Commercial Law, maritime and industrial.
1 hour to Political Economy.
1 hour to Typewriting.
4 hours to a speaking and writing knowledge of English.
4 hours to a speaking and writing knowledge of some other modern language, as German, Spanish, Italian or Arabic.
3 hours to some special course in Transportation, Chemistry, Microscopy, Commercial Technology or Stenography.

The Lesson for Americans to Learn.

But, you may say, what is all this to us? Have we not the finest system of public schools in the world? Have we not any number of manual training schools and numerous Pratt and Armour Institutions? And finally, have we not a great many engineering schools as good as the best, even in Germany? And have we not "Commercial Colleges" without number? Suppose I grant all this, may I not still say that the common schools give no special preparation for any kind of employment; that the manual training schools likewise fit for nothing in particular; that our engineering schools fit for very narrow lines of professional employment and commonly educate men away from the industrial pursuits rather than towards them; and as for our so-called commercial colleges what do they teach beyond arithmetic, book-keeping, stenography and typewriting? Where then does the scientific training for the manufacturing and commercial industries come in? I submit that it does not come in at all. That our factories and business houses are largely managed by men of little or no scientific training, who have learned their craft in the traditional way, who are, however, of an inventive turn of mind and who read the trade journals. They are a great credit to the system that has produced them, and many of them have become self-educated into an excellent state of efficiency; but they are far from the ideal directors of such business and very far indeed from the standard already achieved in Germany.

The most essential conditions of our future material prosperity, therefore, are, as I conceive them, a specific scientific training for the directors of each and every kind of manufacturing and commercial activity. This is the burden of my address; the imperial and paternal government of Germany has worked out this problem to a most fruitful issue, but probably no other country could duplicate it. England has been trying for ten years to do so, but with very poor success; instead of highly educating a few leaders and directors of industry and commerce, they are vainly trying to raise the whole class of apprentices and clerks by a wholesale system of shallow night-school instruction. Surely a duplication of the imperial German system is not to be thought of in this union of 45 independent States. The great question for us to solve is how to obtain a corresponding specific training for our industrial officials. The problem is a difficult one; to expect that our American municipalities would engage in such a rational expenditure of funds is beyond our credulity or hope. Our State Legislatures could hardly be expected to realize this need so fully as to inaugurate and consistently to support a series of such schools. The National Government now pays out directly to the several State agricultural colleges about a million dollars a year. If this amount, or more, could be annually devoted to a properly administrated series of "mono-technic" schools, suitably located, they would soon prove their worth and probably the larger industrial establishments would soon follow by joint effort in establishing additional ones. It is true that some beginnings have been made. At the universities of Pennsylvania and of Chicago the studies in political and social science have been given a commercial application, and at the State University of Ohio a special course of study has been put in operation covering the clay industries, but not including cement manufacture. All our mining schools fairly cover the theory and some laboratory practice of our various metallurgical operations, and this is usually supplemented by tours of inspection to large typical works.

Doubtless we have other similar beginnings towards the higher industrial and commercial education here contemplated, but we certainly have not yet set ourselves earnestly to solve this problem. It may be that the higher commercial schools and many of the "mono-technic" schools could best be established in connection with our various universities and engineering schools, and yet we seldom find them so connected where they have been brought to their highest development.

Our organized commercial bodies would seem to hold out the greatest promise of favorable auspices for the inauguration of such a system of "mono-technic" and commercial schools, not a single example of either of which is now found in this country. The problem is, however, not without its difficulties, and before anything is done or even recommended, the whole question should be looked into by a commission appointed preferably by the National Government through the Bureau of Education. Should not this society take the initiative in such a movement? I believe it should. I believe the future material prosperity of this country is very largely dependent on how we solve this problem. Let us remember that we can no longer judge of the future by the past; to-day both the successful manufacture and the sale of goods are reduced to exact sciences. Old things are done away and all things have become new. Let us see to it that our ship of state shall be guided by the lights which are now so successfully leading others through the channels of progress, rather than to continue to steer by the vanishing lights of a unique and tortuous past which may soon land us on the sandy banks of delusion and improvidence.

*See an article by Senator White, on Our Inadequate Consular Service, in "The Forum" for July, 1898.

†For a full description of these and also of those of Belgium as well as a complete exposition and analysis of the entire system of English technical education, see Proceedings of the International Congress on Technical Education, held in London, June, 1897, under the auspices of the Society of Arts. See also Prof. James' Report on the Education of Business Men in Europe.

TABLE I.—Particulars of Mule versus Electric-Locomotive Haulage at Scott-Haven, Pennsylvania.

Main haulage.[1]	No. 1 Mine.—Mules.	No. 1 Mine.—Locomotive.	No. 2 Mine.—Mules.	No. 2 Mine.—Locomotive.	Pacific Mine.—Mules.	Pacific Mine.—Locomotive.
Number of mules or locomotives	12	1	12	1	15	1
Number of muledrivers or trainmen	3	2	4	2	5	2
Load hauled per day of ten hours, tons	740	1,000	1,090	1,450	600	1,000
Distance hauled,[1] ft.	5,300	6,500	5,400	5,400	5,400	5,400
Speed miles per hour	3.5	8	3.5	8	3.5	8
Mileage per day[2]	30	55	30	51	35	60
Number of trips made per day	30	25	....	27	....	30
Number of cars hauled per trip[3]	17	35	....	42	....	25
Gage, ins.	43.5	43.5	43.5	43.5	41	41
Weight of rails, lbs. per yd.	16	30 to 55	16	25 to 55	16	30 to 55
Weight of empty car, lbs.	1,100	1,100	1,100	1,100	1,100	1,100
Weight of load, lbs.	2,670	2,670	2,670	2,670	2,670	2,670
Mileage made by original wheels of locomotives	....	9,350	....	....[4]	....	7,500
Cost per ton per mile, approx.,[5] cts.	1.28	1.10	1.00	0.82	1.90	1.25
Rated HP. of locomotives	....	50	....	50	....	50
Weight of locomotives, tons	....	10	....	10	....	10

[1]As distinguished from "gathering," i. e., collecting the loads from and returning empties to the working places in reference to a central or main point or points inside, to and from which the locomotives run.
[2]Varies in Nos. 1 and 2 mines.
[3]Varied in No. 2 and Pacific mines with mules.
[4]New in July, 1896.
[5]Includes interest, repairs, etc.
Note.—The ton referred to in the table = 2,000 lbs.

AN ELECTRIC COAL-MINING PLANT IN PENNSYLVANIA.*

The electric mining plant described is located in Westmoreland county, Pa., at Scott Haven, about 27 miles south of Pittsburg, on land owned by the Youghiogheny River Coal Co. This property includes about 5,800 acres, fully four-fifths of which lies on the west side of the Youghiogheny River. During the last 15 years operations have been extensively carried on and up to the present time about 750 acres have been mined. The several mines are scattered over the property, and were formerly operated by separate steam plants.

It was considered advisable by the company to change this and to adopt a method whereby any or all of the mining operations involved could be performed by power generated at and distributed from a central plant which would be capable of enlargement to meet the requirements for many years to come. Electricity was adopted and a location selected for the generating station, which was approximately in the center of the property, close to the Youghiogheny River. This selection was also influenced by its convenience to the main colliery office, its nearness to one of the mines and the fact that at that point was a large brick building which could be used for housing the machinery.

In this way the extreme distance eventually to be covered was limited to three miles in one direction, and four in the other. The present capacity of the power station was determined by considering the character and amount of machinery to be operated at the mines selected to be fitted up. This was as follows:

	HP.
Three locomotives, the average capacity of each being 1,167 short tons of coal, plus refuse, hauled about 1 mile per ten-hour day, say	150.0
Five pumps, of a total capacity of 800 U. S. gallons per minute	40.5
Three fans, of a total capacity of 270,000 cu. ft. of air per minute	105.0
Two screens (only one installed yet)	17.5
One machine shop	10.0
Twelve coal-cutting machines	152.0
Total full load of motors, HP.	475.0

The total number of motors was to be 29, including two on each locomotive, and the average was 18.2 HP.

The boiler plant as installed consists of six 125 HP. externally fired, horizontal, steel tubular boilers, 66 ins. in diameter and 18 ft. long, with 58 4-in. tubes. The working pressure is 100 lbs. per sq. in. These were arranged in two batteries of three each, with independent sheet iron chimneys 32 ins. in diameter and 60 ft. high. Each boiler delivers steam through a 5-in. pipe to a 12-in. header running the whole length of the boiler room. Feed water is taken from a 130-ft. artesian well, and from the pit of mine No. 1, the water from both being pumped into a 35,000 gallon mixing and settling tank. Fuel is hauled by mules on a timber trestle close to building and dumped into hoppers at the rear of the boiler room. There are four McEwen 150-HP. center-crank single-valve horizontal non-condensing engines, with automatic cut-off and cylinders 15 x 16 ins. These are placed in a line parallel to the backs of the boilers and are supplied with steam through 5-in. taps, which pass through the brick wall separating the engine from the boiler room. Exhaust steam is taken care of by a 10-in. pipe

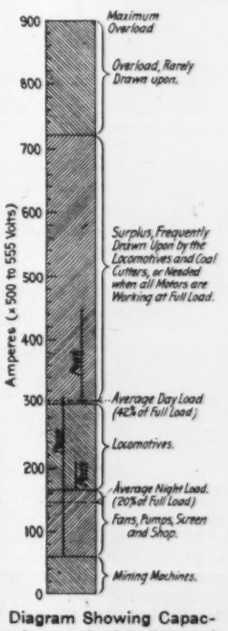


Diagram Showing Capacity and Loading of Power Station of the Youghiogheny River Coal Co., Scott Haven, Pa.

*Abstract of a paper read by Mr. William S. Gresley before the Institution of Civil Engineers.

beneath the floor, which ends in a 500-HP. Hardwick feed-water heater.

The belt wheels of the engines are 64 ins. in diameter, with a 16-in. face, each engine driving through a 15-in. belt a General Electric 100-K-W. 4-pole railway generator running at 650 revolutions per minute. These machines have a no-load voltage of 500, and are over-compounded 10%, giving a full load voltage of 550, and will safely carry a 25% overload for 15 minutes. A suitable switchboard is arranged to permit parallel running, or almost any combination of generators and circuits.

In considering the question of transmission a 10% drop was allowed in feeders, the longest of which would be about 17,750 ft., although the average was 6,518 ft. The transmission lines are nearly all bare copper wires or cables supported on insulators and poles in the customary way, except that separate feeders are run in most cases for cutters, fans and pumps, each set using, however, a common return. Where it was necessary to cross the river, submarine cables were employed. In each case these were 550 ft. long, the sizes and use being as follows:

One cable 0.257-in. in diam...	Feeder for pump in No. 4 and South West mines.
Two cables 0.460-in. in diam..	Feeders for locomotive, pump and fan at Pacific mine.
One cable 0.502-in. in diam...	Feeder for locomo., pump, fan and coal cutters in No. 2.
One cable 0.699-in. in diam...	Bunched return for all west side mines.

The overhead trolley with rail return is used for haulage, while power or light wires are hung along the tops and sides of tunnels, headings, drifts, or galleries. Daniel-Garton lightning arresters and switches are placed just outside pitmouths or buildings containing motors. The mine equipments are much the same, and the following description of mine No. 1 will suffice for an understanding of all.

The track, 3 ft. 7½-in. gage, is of 30-lb. rails spiked to sleepers spaced 24 ins. c. to c. Where loaded trains are started the rails are 55 lbs. per yard. The locomotive has two 25-HP. enclosed motors geared to the two sets of 28-in. chilled cast-iron drivers. The motors are series-wound and are operated by a series parallel controller, the operator also having within easy reach the reversing lever, brake lever, etc. The locomotive weighs 10 tons, and has a draw-bar pull of 2,500 lbs. at a speed of 8 miles per hour. As operated it hauls 665 mine cars, containing about 1,000 tons of coal, with refuse, a distance of 6,000 ft. in 10 hours. Table I. affords a comparison of electric and mule haulage, showing the considerable saving resulting from the use of the former.

For drainage, a 6½ × 8-in. horizontal triplex Knowles' pump is geared to a 10-HP., 4-pole, shunt-wound, slow-speed motor. This pump is capable of raising 150 gallons per minute against a head of 150 ft. For ventilating, an 8 × 3½-in. Capell fan is belted to a 25-HP. multipolar motor. The fan runs at 625 revolutions per minute and discharges 75,000 cu. ft. of air per minute.

Table II. gives the particulars of the electric ventilating apparatus used at the Pacific mine and mines Nos. 1 and 2.

TABLE II.—Particulars of Electric Fan Ventilation at Scott-Haven, Pennsylvania.

Type of fan, Centrifugal; name, Capell.

	No. 1 mine.	No. 2 mine.	Pacific mine.
Diam. of fan, ft.	8	12.5	8
Width of fan, ft.	3.5	5.	3.5
Revolutions per minute	210	124	210
Volume of air passed, cu. ft. per min.	60,000	78,050	61,600
Draft gage, ins.	1	1.2	....
HP. of motor	25	50	30
Speed of motor (r. p. m.)	625	625	625
How connected	belt	belt	belt
HP. input	16	20.24	17
HP. in air circulated	9.5	15.	12
Mechanical efficiency, %	59	72	60
Fuel used per 24 hrs. in lbs. (estim.)	1,800	2,800	1,900
Approx. cost of fuel, cts.	20	31	21
Distance from power house, ft.	800	2,050	17,750

There are eleven Jeffrey chain coal cutters each driven by a 12-HP. motor. These work at an average distance from the power house of 9,700 ft., and during two shifts of nine hours each undermine about 800 tons of coal. To permit shifting about, each motor is provided with a reel holding 300 ft. of heavily insulated twin concentric cable. These machines cut through veins of a conglomerate of fragments of coal measure, often cemented together by iron pyrites, and this without any apparent damage to the cutters. Table III. affords a fair idea of the dimensions of these cutters and the various operating data.

TABLE III.—Data pertaining to Jeffrey Coal Cutters in Use at Scott-Haven, Pennsylvania.

Depth of cut made by machine	69 ins.
Width of cut made by machine	36 "
Height of cut made by machine	4 "
Weight of machine	2,800 lbs.
HP. of motor on machine	12 HP.
Area under-cut per run or cut	17 sq. ft.
Position of cut in the seam	A few ins. above the floor
Time occupied in making one cut	4.5 mins.
Power consumed when cutting	15.4 HP.
Power consumed when backing out of cut	2.8 "
Average number of cuts or runs made per shift	30
Number of shifts worked per day, about nine hours each	2
Tons (of 2,000 lbs.) produced per shift per machine	60 tons
Time occupied cutting	About three hours
Time occupied moving machine about, changing bits, etc.	About six hours
Average number of cuts made in each 21-ft. room	Seven
Number of bits or knives upon a chain	Forty-five
Weight cut per chain used up	35,000 tons (of 2,000 lbs.)
Production per man, by machines, per day	6 tons
Production per man, by pickwork, per day	4 "
Number of 21-ft. rooms apportioned to each machine per double shift	24 rooms
Number of men operating each machine per shift	Two men
Fewer men employed where machines operate, or increased production per miner by use of machines	33%
Less pit room required where machines operate	33%
Output per machine per year	28,000 tons (of 2,000 lbs.)
Cost of blasting and loading up machine-cut coal	One-half pick-mining rate
Cost of under-cutting by machines	One-eighth pick-mining rate
Approximate saving by machines, including renewals, supplies, interest and depreciation, per 2,000-lb. ton	10 cts.
Proportion of machine-cut coal to total output in mines using machines	70%
Increased yield of lump coal due to machines	About 3%

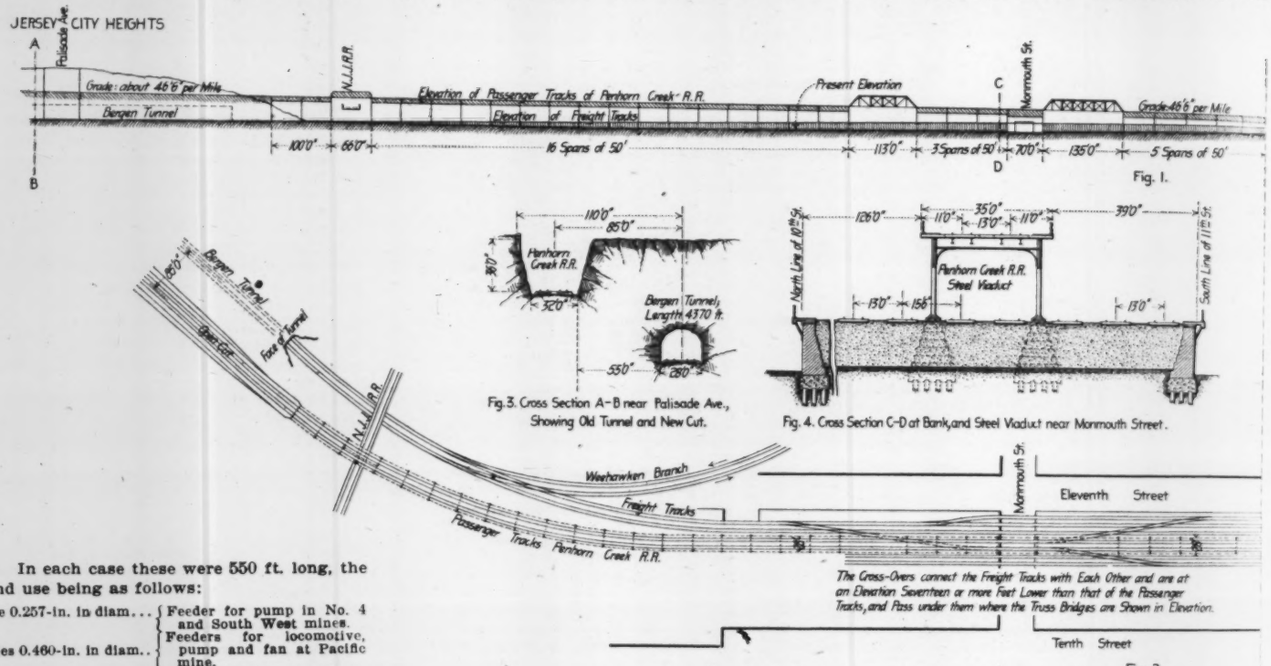
The electrical apparatus installed displaced the following:

Forty mules on the main haulage lines; 12 mules working pumps or hauling water tubs; 20 men and boys driving mules, pumping and bailing; 6 men attending to ventilating furnaces; 3 steam pumping plants and 33% of the miners, where coal cutters are used. On the other hand, it was necessary to establish a mechanical department quite unlike anything existing in the old system. This is in immediate charge of a competent electrician, who is responsible for the working of the plant, and hence passes upon all men operating coal cutters and other mining apparatus.

Formerly, when coal was burned at 12 different places, 14 tons, valued at $5.60, were consumed each 24 hours, while at present the centralized plant consumes 17 tons of mixed slack and coal, at a cost of $3.75, in the same time, performing however, besides the pumping and ventilating, work formerly done by men and mules.

From a series of readings, taken every ten minutes during three working days, the average current for each of the five coal cutters in mine No. 1 was found to be 26.2 amperes, while the "repeated" maximum was close to 75 amperes. During this test separate generators were operating two locomotives, two fans, four pumps, and one screen, and records were taken of the current required by these. The plotted results form extremely irregular curves ranging all the way from 60 to 350 amperes, while fluctuations of as much as 100 amperes occur in a few seconds.

The station had, as a whole, at the time of the test, an average day load of close to 300 amperes, and an average weight load of about 140 amperes. The full capacity of the station is indicated by Fig. 1, which shows the average proportion of output furnished to the mining machines proper, the fans, pumps, etc., and the locomotives, and the height of the maximum peak belonging to each and apt to be called for at any time.



TRACK ELEVATION OF THE

The installation cost about $117 per HP. of engines; operating, stores and repairs cost about $25 per HP. per year, or about 3 cts. per ton of coal produced or delivered at the tips. It is estimated that the coal cutting portion of the outfit is paying about 50% on the original investment, the apparatus apart from this represents an investment paying about 25%.

Comparison between the old and new methods of mine haulage is given in Table I., a study of which, in connection with similar data, published in Engineering News of Feb. 24, 1898, will prove of interest.

TRACK ELEVATION OF THE ERIE R. R. THROUGH JERSEY CITY, N. J.

An important piece of track elevation work, which will include some unusual and specially interesting features, is the elevation of the Erie R. R., from the Jersey City terminal station to Jersey City Heights. The present railway crosses at grade all the streets from the river front back to the high bluffs under which the line passes by a tunnel, and it is only by the maintenance and operation of gates, more or less obstructive to the uses of the streets, that accidents are avoided. After long negotiations between the city and the railway authorities the latter agreed to elevate its tracks and thus eliminate all grade crossings.

In working out the plans, however, the railway included an important improvement by which the present Bergen tunnel through the Jersey City Heights will be avoided by its passenger trains. This tunnel is 4,381 ft. long, and the passage through it is a source of much discomfort in the summer, all the car windows and deck lights being necessarily closed in order to exclude the smoke and gas.

Besides this, all the passenger and freight traffic of the whole Erie R. R. entering the Jersey City terminal, including all the trains over the Erie's numerous suburban branches, are now compelled to pass through this tunnel. As trains are run through the tunnel on the block system, and no train is allowed to enter the tunnel until the train ahead has passed out of it, a fixed limit is set to the number of trains which can arrive or depart from the Jersey City terminal in a given time. During several hours of suburban travel in the morning and again in the afternoon, the tunnel is given up wholly to the use of passenger trains; and the freight traffic is stopped.

The plan adopted is to retain the present tunnel line for freight traffic only, and build a new passenger line in open cut across Jersey City Heights.

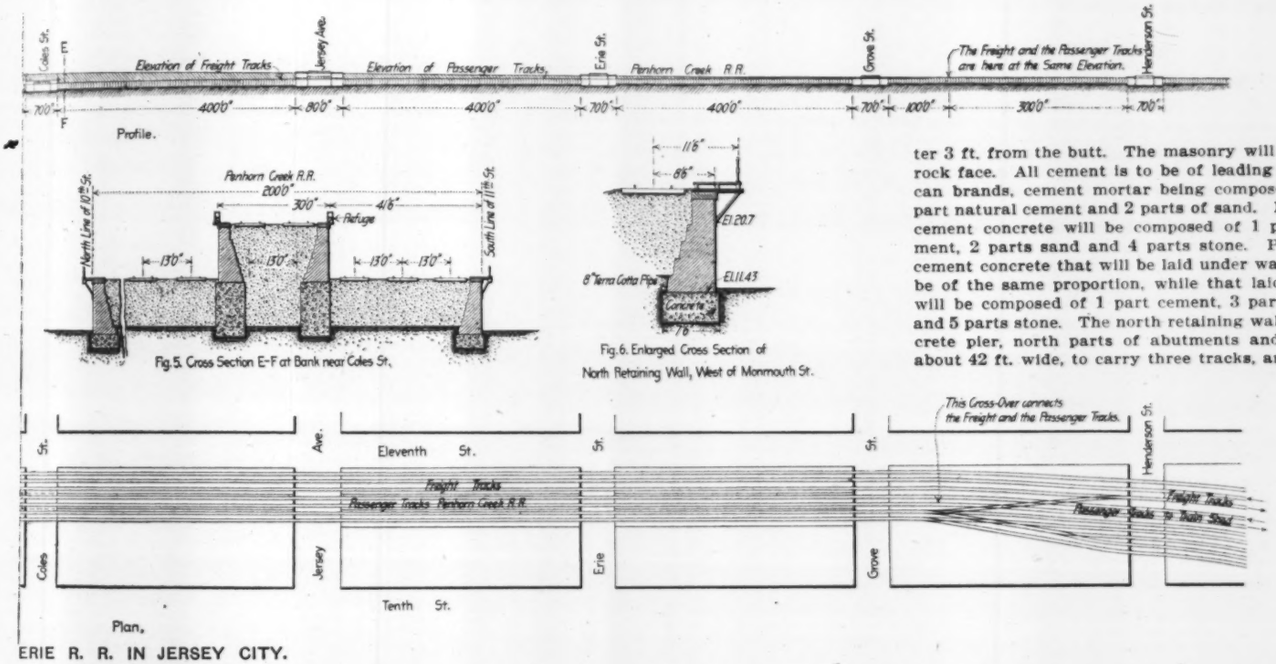
Figs. 1 and 2 represent the plan and elevation of part of the work proposed. Beginning at a point west of the terminal, the passenger tracks will rise for some 2,000 ft. to Henderson Street—the first street crossed. The freight yard branches will also grade up to the new elevation of the passenger tracks at Henderson Street. In all, six streets will be bridged over, to give a clear headway of 12 ft. The freight tracks, after crossing the last street, will grade down to the present elevation at the tunnel. About 2,400 ft. from the terminal, however, at a point just east of Grove Street, the two passenger tracks will begin to rise above the freight tracks (continuing parallel to them) by a grade of 46½ ft. per mile. This grade continuing up to the Heights, through which the line will pass in an open cut having a maximum depth of 36 ft. The tracks in the cut will be about 45 ft. above those in the tunnel, and the center lines of the cut and tunnel will be 85 ft. apart, as shown in Fig. 3. This new line is styled the Penhorn Creek R. R., and beyond the Heights it will descend to the present grade of the main line across the Jersey meadows.

For the freight tracks there will be vertical masonry retaining walls, with a solid earth filling between them, the width being from 100 ft. to 200 ft., the latter width taking in the entire block between 10th St. and 11th St. The walls will be of stone, with concrete foundations supported by piling. An enlarged section of the wall is shown in Fig. 6. The bridge abutments will be of generally similar construction. The piles are spaced 33 ins., 36 ins. and 45 ins. apart, c. to c., with a load of 16 tons per mile. Without the piles the pressure would be 1.8 tons per sq. ft. of foundation. Not all of the foundation are piled.

For the passenger tracks, a similar construction will be followed as far as Coles St., the width being 30 ft., but from that point to the Heights there will be a steel viaduct with 50-ft. plate girder deck spans, and plate girder and truss bridges over roads and railway tracks. The total length of this viaduct will be about 1,750 ft. Figs. 4 and 5 show the construction of the viaduct and bank, respectively. The viaduct will have two rows of columns, 28 ft. apart, c. to c., connected by longitudinal and transverse plate girders, the latter of which will support the four lines of floor beams. A footwalk is provided on each side, the total width over the floor of the viaduct being 35 ft.

When this work is completed, freight trains will run between Rutherford and the Weehawken yard, or the main freight yard or elevator at Jersey City, without using any track or switch used by passenger trains of either the main line or branches. The separation of the freight and the passenger traffic will then be absolute. Yard work is now in progress, the contract having been let in April, but the construction of the new passenger line will not be undertaken at present. The foundations will, however, be put in during the construction of the embankment and retaining walls, and the cut through the Bergen hill may also be excavated.

The north retaining walls and the north parts of the abutments will first be built and earth filled in to form a bank wide enough for the main tracks, so that the construction of the south walls and the south parts of the abutments can then be proceeded with. The excavation for foundations will be in some cases as deep, 10 or 12 ft. below the present surface, the material being paid for as excavation and being used for filling. The piles must be at least 8 ins. diameter at the small end, and 12 ins. diameter 3 ft. from the butt. The masonry will have a rock face. All cement is to be of leading American brands, cement mortar being composed of 1 part natural cement and 2 parts of sand. Natural cement concrete will be composed of 1 part cement, 2 parts sand and 4 parts stone. Portland cement concrete that will be laid under water will be of the same proportion, while that laid in air will be composed of 1 part cement, 3 parts sand and 5 parts stone. The north retaining walls, concrete pier, north parts of abutments and filling about 42 ft. wide, to carry three tracks, are to be


Coles St.
Jersey Ave.
Erie St.
Grove St.
Henderson St.
Elevation of Freight Tracks.
Elevation of Passenger Tracks.
Penhorn Creek R.R.
The Freight and the Passenger Tracks are here at the Same Elevation.
Profile.
Penhorn Creek R.R.
Refuge
North Line of 10th St.
South Line of 11th St.
Fig. 5. Cross Section E-F at Bank near Coles St.
6" Terra Cotta Pipe
Concrete
Fig. 6. Enlarged Cross Section of North Retaining Wall, West of Monmouth St.
This Cross-Over connects the Freight and the Passenger Tracks.
Eleventh St.
Freight Tracks
Passenger Tracks Penhorn Creek R.R.
Freight Tracks to Train Shed
Passenger Tracks to Train Shed
Tenth St.
Plan.

ERIE R. R. IN JERSEY CITY.

completed by October, 1898, and all the work is to be completed by October, 1899. The contractors are Grattan & Jennings, of Buffalo, N. Y.

The plans were prepared by Mr. C. W. Buchholz, M. Am. Soc. C. E., Chief Engineer of the Erie R. R., to whom we are indebted for blue prints and specifications.

BOOK REVIEWS.

AUTOMIBLES SUR RAILS.—Par G. Dumont, Ingenieur des Arts et Manufacturers. Encyclopedie Scientifique des Aide-Memoire, M. Leaute, Directeur. Paris: Masson & Co. Paper; 7⅛ × 4⅝ ins.; pp. 184; illustrated.

This is practically a continuation of a previous publication of the same author on "Electromotors and their Applications." In his preface Mr. Dumont notes that the first application of a self-moving vehicle on rails, for ordinary street traffic, was that of Andraud and Tessie du Motay, who, in 1838-40 built a machine at Chaillot, France, operated by compressed air and seating eight persons. It worked well enough, but was not practicable. In 1848, a steam train, carrying 60 passengers, was worked for a time on some secondary lines near Bristol, England; and in 1859, steam tramways were successfully operated in the United States. In 1876-77 the English engineer, Grantham, introduced the first type of vehicle in which the steam motor was made a part of the vehicle itself, and in this same year, 1877, Mekarski established at Nantes the first public automobile service operated by compressed air. The first horse tramway in France was built in 1856, on a line extending from Paris to St. Cloud, and it was called the

"American" railway; but the first horse-car line in Paris itself was not in operation until 1875.

Mr. Dumont goes on to treat his subject under the seven heads of traction, by steam motors, by compressed air, by gas-motors, by carbonic acid and by ammonia engines, by cableways and by electric motors. Without going into the detail of each class it is interesting to the general reader to indicate how many methods have been proposed, and more or less successfully applied, for supplanting the horse on street and suburban lines of travel on rails.

Under the general head of steam motors we have the Rowan system of 1882, with vertical boiler and a motor beneath the carriage; the Serpollet system of 1887, in which instantaneous vaporization is secured by very thin boiler-tubes exposed directly to the fire; the steam turbine motor of A. Gerard, not yet actually in service; the Versailles-Maule system, which resembles the Rowan motor, but carries the motor-engine and boiler on a separate bogie-truck; the Lamm and Francq system, which omits the boiler and fire and carries a reservoir of hot water under pressure; and the Honigman system of fire-less boiler, in which the escaping steam is reheated by contact with very concentrated soda, and transmits this heat to the boiler and uses it again in the vaporization of water. Unhappily, the action of the soda upon the metal parts of the apparatus rapidly destroys them. Under compressed air motors, the author commences with the Mekarski system of 1877; he follows with the compressed air-motor of Hardie, tried in 1879 on the Metropolitan Elevated Railway of New York; the Scott Moncrieff motor of 1881; the Beaumont compressed air locomotive of 1885, and the Popp-Conti system, which differs from the Mekarkski device in using the air at a lower relative pressure. Motors operated by gas were introduced by Messrs. Banks and Baines in 1885, upon tramways in Australia. The first application was not successful, but it stimulated inventing in Germany, England, the United States and in France. The Luhrig system was brought out in Germany in 1893, upon the Dresden-Wildermann railway, 2½ miles long. Two Benz motors, of 7 or 8 HP. each, were operated by the explosion of gas, and the system is now quite generally used in Germany. Mr. Borig, of Berlin; Connelley, of New York; Pintch; Hasse; Holt & Crossley, of Manchester, and Grob, of Leipzic-Entrsch, have all patented devices for the application of gas to tram-motors. Mr. Barbet uses a mixed system of compresed air and gas; and Mr. Moutelar employs the first to start the train and then keeps up this motion by gas-engines.

Among petroleum motors the best known is the Daimler; but the Roger motor is being successfully tested in France. Motors operated by some very volatile liquid take their origin from the liquifaction of carbonic acid by Faraday, and the elder Brunel is credited with the invention of the first motor of this type. In 1835, Ghilliano and Christin, and in 1862, Marquis took out patents for carbonic acid motors; in 1891, Belzon, in Germany, actually built a carriage operated by a carbonic acid motor; and in 1892, "The New Power Co.," of New York, introduced a similar motor for street railways. In these motors the gas was carried in long, steel or iron bottles, generally under a pressure of 75 atmospheres, and was sent directly to the cylinders of the engine, where it was fired by a gas-jet. In 1821, Gurney advocated the use of ammonia as a producer of power, and in 1871, Dr. Lamm, in America, and Gen. Beauregard and M. Tellier, in France, made experiments promising success. In 1893, Mr. T. W. Morgan-Draper made an ammonia-engine, basing his system upon the property possessed by anhydrous ammonia of liquifying at about — 34° C., at the ordinary pressure, and at + 27° C., under a pressure of ten to twelve atmospheres: By heating a vessel containing liquified anhydrous ammonia to more than + 27° C., gases are emitted generating a tension of ten to eleven atmospheres, and this pressure is utilized in an ordinary engine. The escaping vapor is absorbed by water and the heat generated is utilized in heating the ammonia receptacle. At the New Orleans Exposition of 1893, Mr. F. F. MacMahon operated a motor of this type, weighing 7 tons, and capable of making a run of 24 miles.

Cable traction and electric motors, operated by both overhead, underground and interrupted conductors, are fully described by our author in separate chapters. The first application of electricity to street-car service in Paris was in 1881, at the Electrical Exposition of that year; but it was not until 1890 that an actual test was made by equipping a line, running between the Madeleine and Levallois, with the accumulator system. In 1892-93 similar lines went into operation, from the Opera House to St. Denis, and from St. Denis to Neuilly; in 1897 the system was further extended from Neuilly to Courbevoie, and from the Place de la Republique to Aubervilliers. A large part of this section of the work is devoted to the description of American apparatus, and this will not be repeated here. In his concluding chapter Mr. Dumont makes a comparison of the cost of operating the different systems of street-car traction described. This comparison, translated from the metric units, stands as follows:

	—Steam.—				Electric.	
Per car-mile	Rowan system.	Serpollet system.	Compressed air.	Gas.	Trolley.	Accumulator system.
Number of places for passengers	43	50	50	50	50	50
Weight fuel consumed, lbs.	10.6	9.0	15.3	58.2*	5.†	10.8
Operating cost:						
Motive force, cts	3.9	3.3	7.7	6.4	5.3	4.2
Wages, cts	2.6	2.6	2.6	2.6	2.6	2.6
Water, oil, repairs, etc, cts.	4.8	3.7	3.5	4.3	2.2	4.2
Totals, cts	11.3	9.6	13.8	13.3	10.1	11.0
Sinking fund, @ 10%, cts.	3.5	3.5	4.8	3.4	5.5	4.2
Total expense, traction, cts.	14.8	13.1	18.6	16.7	15.6	15.2

* = cu. ft.

†This consumption of 5 lbs. of coal per car-mile is deduced from experiments made on the trolley lines of Rouen.

The above table is supposed to represent a typical system, 18 miles long, equipped with 30 cars, with a part of these held in reserve, and each car averaging a daily run of about 90 miles. In the items of wages paid and cost of materials, etc., no direct comparison is possible with American practice; but as the motive cost is the true standard of economy in the various systems of traction, some comparison can be made here. The reports of the Railway Commissioners of Massachusetts and New York, for 1897, show that the cost of electric motive power on the street railways of those states ranged from 2 to 3 cts. per car-mile, in the majority of cases, with some lines reducing this cost to one cent. This is in spite of higher wages paid; and the reduction in cost is wholly due to excellence of equipment, the longer lines operated, and to the valuable experience gained by American managers in the operation of electric railway systems. It is difficult to tell just what the "total expense of traction" in the above table does include; but in the case of the Massachusetts street railway system for 1896, the total expense of operation, as deducted from gross to obtain net earnings, was 15.7 cts. per car-mile; this average is for 1,277 miles of main track, averaging in cost $46,041 per mile, and of which 1,241 miles were operated by electric power.

AUTOMOBILES SUR ROUTES.—Par L. Perisse, Ingenieur des Arts et Manufactures. Encyclopedie Scientifique des Aide-Memoire, Paris. Paper; 7½ × 4½ ins.; pp. 206; illustrated.

This is a companion work to "Automobiles sur Rails," lately published by the same house and reviewed in this journal. The history of motor-vehicles for ordinary roads is taken up, from the steam-carriage of Cugnot, of 1770, and the author briefly describes the various English road motors which preceded and immediately followed the application of steam to railways. Mr. Perisse follows this historical portion with a general discussion of motors, transmission gear and accessories, and then describes the various types of motors designed for use on highways under the general heads of: Carriages for personal use; vehicles for common passenger transport, or omnibuses, and motors for carrying heavy merchandise. This is the valuable portion of the book, but the space here available forbids any adequate abstract. The conclusion of the author, resulting from a careful study of all existing methods of road-motor construction and practice are worth noting.

Mr. Perisse first points out the fallacy of the arguments usually advanced by the opponents of motors in comparing the power exerted with that of the horse and in ordinary vehicles. He claims that the results of all the recent motor-trials show that cost of traction is incontestably less with motors than with horses, notwithstanding the cost of fuel and materials. The one element still to be settled by long experience only is the expense of repairs and the daily cost in constant work with a motor. This is the question which the development of the motor can alone settle, by simplified mechanism and proper design in all parts of the apparatus. In comparing the various types of motors, he finds that the use of steam generally requires a heavy generator, when sufficient power is wanted; and the problem is one of weight and the employment of a clumsy fuel, with the added disadvantages of escaping hot gases and steam. The advantages are, the ability to vary the speed with steam pressure and to regulate the consumption of fuel by the amount of actual work to be performed. It is undoubtedly the motor for the transport of heavy loads, and devices are already in use for suppressing or mitigating any nuisance from smoke and steam. The steam-motor utilizes for adherence a part of the useful load.

Petroleum motors do not permit the regulation of the speed by the power produced, as in the case of steam. Mechanism, often very complicated, is necessary to bring about this change in speed. The petroleum motor also requires great care in its management, and the cost of traction is often very high, owing to the fact that the consumption of fuel is practically constant and independent of the work done. Under ordinary use there is great vibration of the body of the vehicle, resulting from the great speed of explosion-motors; and, finally, there is an objectionable odor from the burning oil, which may perhaps be eliminated by better construction. The advantages of the petroleum motor are that it may almost instantly be put into service; the fuel is easily handled; the dead weight of the vehicle is less than that of the steam-motor, and repairs are thus less costly. It is best suited for rapidly transporting passengers from one town to another; and it is the true tourist vehicle, for when speed is demanded, it can be secured even at less fuel economy. It may be applied to hotel omnibuses and to family coaches, but the useful load should never exceed about 3,300 lbs.

Electric motors present great advantages, as the traction is easy and regular, silent and unaccompanied by objectionable odors or steam. But the accumulator is heavy, cumbersome and of little capacity in proportion to the dead weight carried. In the present development of electric road-motors, it is difficult to foresee how these vehicles can be made to travel over a route of 36 to 60 miles. It is probably best adapted to city use, for comparatively short runs, and it may be sufficiently developed to supplant the cab-horse. As applied to omnibus service in England the results are not very promising.

A TOWN IS TO BE MOVED on the Messaba range of Minnesota iron mines. The town of Eveleth has been in existence about four years, and has a population of 2,500, with hotels, banks, stores, etc. Late exploration has brought to light a bed of rich iron ore beneath this town that is valued at not less than $15,000,000, and the town must move on. The townsite proprietors had made stringent reservations in their deeds as to mineral rights, and they now offer all lot-owners in the western half of the town free lots in a better site eastward, with streets graded and sidewalks laid. They are now also seeking proposals for the wholesale removal of buildings on the ore tract. The owners of the land are Robinson & Flynn, Murphy & Dorr and E. M. Fowler, all of Detroit, Mich. They bought the land for the pine timber upon it, without dreaming of the wealth below the ground. They now receive about $300,000 annually in royalties upon the Fayal and Adams mines alone, says the Chicago "Tribune."

WEATHER TABLE FOR JULY, 1898. (Furnished to Engineering News by the Department of Agriculture.)

	Stations.	Temperature. (Degrees Fahrenheit.)				Wind.			Precipitation. Inches and hundredths.		
		Average.	Max.	Min.	Range.	Velocity in miles per hour. Average.	Velocity in miles per hour. Max.	Direction at time of max. velocity.	Total.	Heaviest in 24 hours.	No. of rainy days.
Northern Cities.	Northfield, Vt.	68.0	94	34	60	7.8	36	NW	1.66	0.72	10
	Portland, Me.	67 8	97	52	45	7.0	27	NW	1.78	0.80	11
	New York City	74.1	99	57	42	8.6	36	NE	4.76	1.96	12
	Pittsburg, Pa.	77.2	99	51	48	5.0	24	W	2.56	0.96	11
	Chicago, Ill.	73.4	94	59	35	13.2	48	N	1 94	1 22	5
	Omaha, Neb.	75.3	95	59	36	7.3	32	NE	4.20	3.56	7
	St. Paul, Minn.	72.8	91	54	37	7.0	29	W	1.94	1.35	6
	Duluth, Minn.	65.9	90	46	44	9.2	30	NW	1.33	0.53	10
	Bismarck, N. Dak.	69.8	97	38	59	9.3	34	NW	1.64	0 53	6
	Average	71 6	95	50	45	8.3	33	—	2.42	1.29	9
Southern Cities.	Washington, D. C.	78.8	101	54	47	5.3	32	NW	2.86	1.24	10
	Louisville, Ky.	79 6	97	58	39	6.8	31	W	2.15	0.94	7
	St. Louis, Mo.	78.2	96	57	39	7.8	35	W	7.44	5.08	12
	Savannah, Ga	81.2	99	63	36	7.2	35	NW	8.53	3.18	19
	Kansas City, Mo.	77.3	96	61	35	7.4	50	NW	4.93	1.93	9
	Jacksonville, Fla.	82.0	98	67	31	7.2	36	S	12.03	3.25	23
	Chattanooga, Tenn.	79.2	97	59	38	6.0	35	NW	6.48	1.80	15
	New Orleans, La.	81.5	97	70	27	7.4	32	NW	4.57	1.25	14
	Memphis, Tenn.	79.2	95	62	33	7.7	42	SE	4.28	1.84	13
	Palestine, Tex.	80.8	101	62	39	5.6	30	SE	2.29	1.15	9
	Average	79 8	98	61	36	6.8	36	—	5.56	2.17	13
Western Cities.	Helena, Mont.	65.4	90	36	54	7.9	39	SW	1.71	1.47	7
	Port Angeles, Wash.	56.4	82	42	40	8.0	28	NW	0.17	0.08	4
	San Francisco, Cal.	56 2	88	47	41	15.8	41	W	None.	.0	0
	Salt Lake City, Utah.	75.9	97	49	48	5.8	29	S	0.18	0.08	4
	Santa Fe, N. Mex.	68.2	89	49	40	5.7	34	NE	2.31	0.50	13
	Denver, Colo.	72 4	96	49	47	7.9	45	NW	0.67	0.23	10
	Yuma, Ariz	91.9	113	73	40	—	38	SE	0.00	.00	00
	Average	69.5	94	48	44	8.5	36	—	0.72	0.34	5